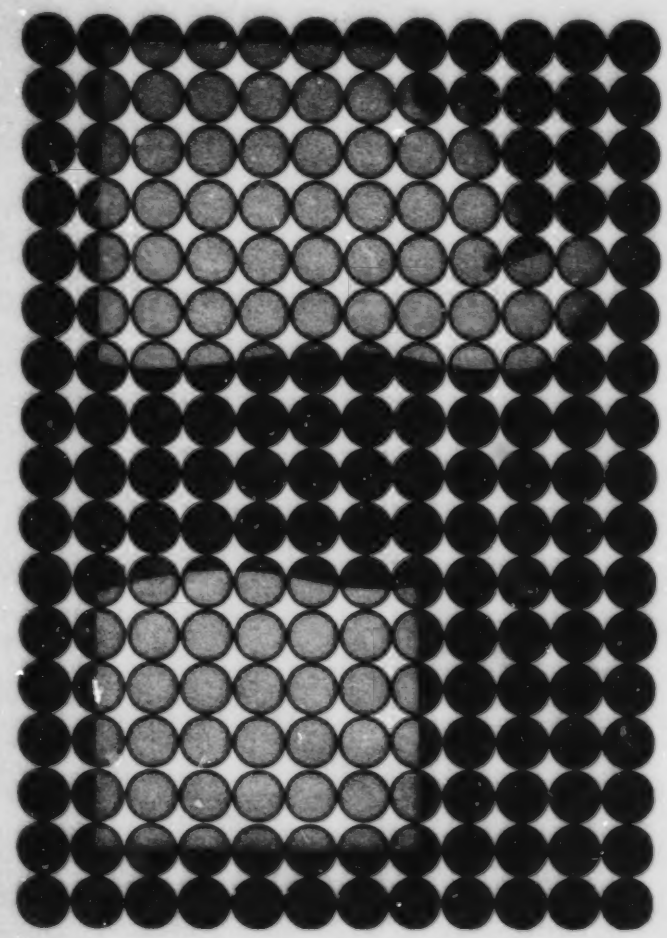

CANADA-MANITOBA Soil Survey

Soils of the St. Eustache, Springstein, Brunkild, Southwest Perimeter and La Salle River Areas

Report D67

Government of Canada Gouvernement du Canada
Government of Manitoba Gouvernement du Manitoba

SOILS REPORT NO. D67 1989

SOILS OF THE ST. EUSTACHE, SPRINGSTEIN, BRUNKILD, SOUTHWEST PERIMETER AND LA SALLE RIVER AREAS

by

GLENN PODOLSKY

CANADA-MANITOBA SOIL SURVEY

AGRICULTURE CANADA

MANITOBA DEPARTMENT OF AGRICULTURE

DEPARTMENT OF SOIL SCIENCE, UNIVERSITY OF MANITOBA

91-02301/

PREFACE

This interim report and map of the detailed field and laboratory study of the soils of the St. Eustache, Springstein, Brunkild, Southwest Perimeter and La Salle River areas is one in a new series of such soil survey reports covering special interest areas in southern Manitoba. These reports reflect the growing concern by various government agencies that support the Canada-Manitoba Soil Survey, that a knowledge of the development and distribution of the soils of Manitoba is the key to understanding their properties, behavior and response to management. This concern requires that soils be described both in terms of their basic properties and the nature of the environmental setting in which they are found. Thus, when areas such as that in the study require delineation of land of high or low value for crop production or for other uses, the basic reference document is an accurate and reliable soil map.

The land resource information included in this resurvey covers approximately 6 300 ha of land adjacent to the towns of St. Eustache, Springstein, Brunkild, the Southwest Perimeter Strip and La Salle River area. It includes only a fraction of the area covered in the former reconnaissance survey of the Winnipeg Map Sheet Area (Report No. 5, 1953). However, the projected more intensive use of the soils for agriculture and the growing competition for other uses of land in the area has created a need for more up-to-date, more accurate and more detailed soil information. The increased examination of soils in the field, the use of current aerial photography, the use of improved methods of studying soils in the laboratory and the accumulated knowledge of the properties and uses of soils over the years have all contributed to the additional information contained in this new series of reports and maps.

During the course of the resurvey of the study areas, a significant volume of site specific data for the soils mapped in the area was generated, that for practical reasons cannot be included in this interim report. These data are currently being input into the Canada Soil Information (CanSIS) data bank. This computerized system of data management permits automated manipulation and statistical evaluation of large volumes of data for soil characterization and interpretations. These data will shortly be available on request. In addition, the cartographic file of CanSIS provides a capability to produce derived maps of various kinds quickly and inexpensively. The types of derived maps that can be generated from the basic soil map include the sixteen interpretations that are provided in tabular form in this report as well as a number of single feature maps for such characteristics as drainage, texture of surface deposits, slope, stoniness, distribution of salinity, etc. A package of interpretive maps and single feature derivative maps can be made available on request to: The Canada-Manitoba Soil Survey, Dept. of Soil Science, Rm. 362, Ellis Bldg., University of Manitoba, Winnipeg R3T 2N2.

The Canada-Manitoba Soil Survey trusts that this report and accompanying map will be of value to all individuals and agencies involved with the use of land within the map area.

ACKNOWLEDGEMENTS

The study of the St. Eustache, Springstein, Brunkild, Southwest Perimeter and La Salle River areas was conducted as a joint project of the Manitoba Department of Agriculture and Agriculture Canada in response to a request from the Municipal Planning Branch, Manitoba Department of Municipal Affairs.

Grateful acknowledgement is made to the following persons:

R.E. Smith, Director of the Canada-Manitoba Soil Survey for reviewing the manuscript.

J. Griffiths, R. DePape and M. Brown for compiling, drafting and digitizing the sketches and maps.

D. Sandberg for typing, inputting and assisting in preparation of the report.

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The field work was carried out by G.P. Podolsky, assisted by J. Smiley.

HOW TO USE THIS SOIL REPORT

This soils report contains considerable information about the soils, their origin and formation, their classification and their potential for various uses such as dryland agriculture, irrigation, engineering and recreation. The report is divided into four parts: Part I provides a general description of the area; Part 2 describes the methodology used in the study; Part 3 discusses the development, scientific classification and morphological characteristics of the soils in the study area, and Part 4 provides an interpretation of soil properties and associated landscape features as they affect soil capability or suitability for various uses.

The soil map of the study area is compiled on an uncontrolled air photo base which is included in a pocket of the report folder. The map shows the distribution of soil types and associated landscape features that are significant for potential use as field management units. It provides a linkage from landscapes within the study area to the information contained in the report.

To assist the user in retrieving soil information quickly, the following steps are suggested:

If project consists of many individual maps, proceed with STEP 1., if only single map in pocket, proceed with STEP 2 to 6.

STEP 1 Consult the index to map sheets if the report contains many maps. Locate the areas of interest and note the map-sheet number(s) which identify the township and range on each map.

STEP 2 Consult the soil map in pocket of report folder. Locate the area(s) of interest on the map and identify the pertinent map unit symbols. Arabic numerals placed as superscripts following map symbols indicate the approximate proportion of each soil type within the map unit.

STEP 3 Consult the extended legend accompanying the soil map for an alphabetical listing of soil symbols giving the soil name, classification, drainage and related information concerning landforms, nature and depth of materials, and dominant vegetation.

STEP 4 For interpretive information about the soils, consult the appropriate Table in Part 4. Criteria utilized as guidelines in making these interpretations are provided in the Appendix.

STEP 5 Further information concerning the morphological properties and extent of the soils is presented in Part 3 where the soils are described alphabetically according to soil name.

STEP 6 Additional site-specific information not contained in this report is available on request from the Canada-Manitoba Soil Survey, Ellis Building, University of Manitoba.

TABLE 1.

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA JANUARY, 1989

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
Detailed Studies and Surveys								
D1	Pasquia (No. 11)	Pub. 1960	57 200	a,b,d	3	1:63,360	Color	A
D2	Glenlea Research Station	Int. 1963	541	a,b	1	1:7,920	Photo	A
D3	Morden Experimental Farm	Int. 1961	256	a,b	1	1:12,000	Photo	A
D4	Onanole	Pub. 1968	768	a,b	1	1:7,920	Photo	U
D5	York Factory Area	Int. 1969	768	a	3	1:63,360	B&W	
D6	McCreary Tile Drain Project	Int. 1971	64	a,b	1	1:5,000	B&W	A
D7	Brandon Experimental Farm	Int. 1985	768	a,b	1	1:7,920	Photo	A
D8	Portage Potato Farm	Int. 1972	480	a,b	1	1:4,800	Photo	A
D9	Portage la Prairie (No. 17)	Pub. 1972	113 200	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D10	Morden-Winkler (No. 18)	Pub. 1973	71 424	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D11	Deep Lake	Int. 1975	1 400	a,b	1	1:6,000	B&W	R
D12	Thompson Environmental Study	Int. 1976	32	a,b	1	1:1,000	B&W	
D13	Organic Soil Study of Alexander L.G.D.	Int. 1975	29 456	a,b	3	1:63,360	B&W	A
D14	Winnipeg Region	Pub. 1975	306 000	a,b,c	2	1:20,000	Photo	A,E,U,R
D15	Brandon Region	Pub. 1976	73 250	a,b,c	2	1:20,000	Photo	A,E,U,R
D16	Boissevain-Melita (No. 20)	Pub. 1978	262 912	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D17	Roseau River	Pub. 1977	45 200	a,b	3	1:20,000	B&W	A
D18	Orr Lake	Int. 1977	20	a,b	1	1:1,000	B&W	
D19	Pelican-Rock Lake	Pub. 1983	14 080	a,b	2	1:20,000	Photo	A,E,R,I
D20	West Portage-MacGregor	Pub. 1982	124 866	a,b	2	1:20,000	Photo	A,I,E,R
D21	Minnewasta	Pub. 1978	2 560	a,b	2	1:20,000	Photo	A,E,R,I
D22	Killarney	Pub. 1979	4 600	a,b	2	1:20,000	Photo	A,E,R,I
D23	Matlock-Gimli-Riverton	Pub. 1981	18 400	a,b	2	1:20,000	Photo	A,E,R,I
D24	Glenboro	Pub. 1979	5 960	a,b	2	1:20,000	Photo	A,E,R,I
D25	Sandy Lake	Pub. 1980	1 720	a,b	2	1:20,000	Photo	A,E,R,I
D26	Brokenhead	Pub. 1979	10 813	a,b	2	1:20,000	Photo	A,E,R,I
D27	Rockwood	Pub. 1980	12 928	a,b	2	1:20,000	Photo	A,E,R,I,U
D28	Oak Lake	Pub. 1979	1 293	a,b	2	1:20,000	Photo	A,E,R,I,U
D29	Bird River	Pub. 1980	2 560	a,b	2	1:20,000	Photo	A,I
D30	North Shore Lac du Bonnet	Pub. 1980	2 400	a,b	2	1:20,000	Photo	A,E,R
D31	Grindstone Point	Pub. 1979	8 223	a,b	2	1:20,000	Photo	A,E,R

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1989

TABLE 1.

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
D32	Paint Lake	Int. 1980	2 880	a,b	2	1:10,000	Photo	A,E,R
D33	Cranberry Portage	Int. 1980	80	a,b	1	1:5,000	Photo	A,E,R
D34	Dauphin	Pub. 1981	8 005	a,b	2	1:20,000	Photo	A,E,R,I
D35	South Riding Mtn.	Pre.	23 488	a,b	2	1:20,000	Photo	A,E,R
D36	West Interlake	Pub. 1981	10 036	a,b	2	1:20,000	Photo	A,E,I,R
D37	Swan R. Townsite	Pub. 1987	7 680	a,b	2	1:20,000	Photo	A,E,R,I
D38	Hadashville-organic	Pub. 1981	6 475	a,b	3	1:40,000	Photo	A,E,I,R
D40	Falcon L-Brereton L	Pre.	39 311	a,b	2	1:20,000	Photo	A,E,R
D41	Quesnel Lake-North Shore Winnipeg River	Pre.	6 009	a,b	2	1:20,000	Photo	A,E,R
D42	Duck Mountain	Pub. 1982	3 036	a,b	2	1:20,000	Photo	A,E,R
D43	Spruce Woods	Pre.	26 300	e	3	1:40,000	Photo	A,E,R
D45	Pine Creek	Pub. 1983	1 942	a,b	2	1:20,000	Photo	A,E,R,I
D46	Arborg-Riverton	Pub. 1982	2 590	a,b	2	1:20,000	Photo	A,E,R,I
D47	Roblin	Pub. 1983	4 096	a,b	2	1:20,000	Photo	A,E,R,I
D48	Flin Flon	Pub. 1988	4 600	a,b	2	1:20,000	Photo	A,E,R
D49	St. Anne-La Broquerie, Part of L.D.G. Stuartburn	Pub. 1985	105 280	a,b	3	1:50,000	B&W	A,E,R,I
D50	City of Brandon	Pub. 1984	2 980	a,b	2	1:20,000	Photo	A,E,R,I
D51	Westbourne	Pub. 1985	51,456	a,b	2	1:20,000	Photo	A,E,R,I
D52	Notre Dame, Rathwell, Treherne Townsites	Pub. 1984	6 144	a,b	2	1:20,000	Photo	A,E,R,I
D53	Altona, Emerson, Gretna, Ile des Chenes, Landmark, Letellier, Rosenort, St. Jean Townsites	Pub. 1984	14 080	a,b	2	1:20,000	Photo	A,E,R,I
D54	Russell, Binscarth-Townsites	Pub. 1984	3 791	a,b	2	1:20,000	Photo	A,E,R,I
D55	St. Rose Du Lac-Townsite	Pub. 1985	1 536	a,b	2	1:20,000	Photo	A,E,R,I
D56	Souris, Wawanesa, Virden, Townsites	Pub. 1986	6 400	a,b	2	1:20,000	Photo	A,E,R,I
D57	Fraserwood, Inwood, Komarno Townsites, Lake Man. Shoreline	Pub. 1987	1 856	a,b	2	1:20,000	Photo	A,E,R,I
D58	Hallboro, Minnedosa-Townsites	Pub. 1984	4 544	a,b	2	1:20,000	Photo	A,E,R,I
D59	Beaudry Park	Pub. 1986	640	a,b	2	1:20,000	Photo	A,E,R
D60	Rural Municipalities of Dufferin, Grey, Roland, Thompson and Stanley	Pub. 1988	325 000	a,b	2	1:20,000	Photo	A,E,R,I
D61	Meditation Lake	Pre.	3 072	a,b	2	1:20,000	Photo	A,E,R
D62	Wanipigow Lake	Pre.	8 960	a,b	2	1:20,000	Photo	A,E,R

TABLE 1. SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1989

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
D63	Shellmouth Resevoir-N	Pub. 1987	4 650	a,b	2	1:20,000	Photo	A,E,R,I
D64	Assiniboine River	Pub. 1987	4 095	a,b	2	1:20,000	Photo	A,E,R,I
D65	Villages of Hamiota, Elkhorn, Strathclair, Rapid City, Newdale, Birtle, Shoal Lake	Pre.	6 204	a,b	2	1:20,000	Photo	A,E,R,I
D66	Benito-Durban	Pre.	18 432	a,b	2	1:50,000	Photo	A,E,R,I
D67	St. Eustache, Springstein, Perimeter Strip, Brunkild, La Salle R.	Pre.	6 200	a,b	2	1:20,000	Photo	A,E,R,I
D68	Spruce Point Mine Area	Pub. 1987	450	a,b	2	1:10,000	Photo	E,R
D69	Snow Lake	Pre.	2 333	A,B	2	1:20,000	Photo	A,E,R,I
D70	Lorne	Pub. 1987	93 240		3,2	1:50,000	B&W,Photo	A,E,R,I
D71	Whitemouth Peatland	Pub. 1987	10 359	a,b	3	1:50,000	Photo	A,E,R,I
D72	Woodlands R.M.	Pre.	9 728	a,b	3	1:50,000	Photo	A,E,R,I
D73	Elk Island-Victoria Beach	Pre.	2 592	a,b	2	1:20,000	Photo	A,E,R,I
D74	S. Norfolk R.M.	Pub. 1988	70 912	a,b	2	1:20,000	Photo	A,E,R,I
D75	Victoria R.M.	Int.	67 328	a,b	2	1:20,000	Photo	A,E,R,I
D76	Rhineland	Data	64 512	a,b	2	1:20,000	Photo	A,E,R,I
D77	Pembina	Data	27 972	a,b	3	1:50,000	B&W	A,E,R,I
D78	Springfield*	Data	98 270	a,b	2	1:20,000	Photo	A,E,R,I
D79	Rockwood R.M.*	Pre.	116 550	a,c	4	1:125,000	B&W	A,E,R,I
D80	N. Norfolk R.M.	Pre.	110 592	a,b	2	1:20,000	Photo	A,E,R,I
D81	Plum Lake	Pre.	15 500	a,b	2	1:20,000	Photo	A,E,R,I
D82	Hanover R.M.		7 168		2	1:20,000		
			5 632		3	1:50,000		
*	Upgrade of Data Base							
Reconnaissance Surveys								
R1	South Western (No. 3)	Pub. 1940	709 600	d	3	1:125,000	B&W	A
R2	South Central (No. 4)	Pub. 1943	967 600	d	3	1:125,000	B&W	A
R3	Winnipeg and Morris (No. 5)	Pub. 1953	1 419 200	d	3	1:125,000	Color	A
R4	Rossburn and Virden (No. 6)	Pub. 1956	1 372 400	d	3	1:125,000	Color	A
R5	Carberry (No. 7)	Pub. 1957	967 600	d	3	1:125,000	Color	A
R6	West-Lake (No. 8)	Pub. 1958	592 800	d	3	1:125,000	Color	A
R7	Grandview (No. 9)	Pub. 1957	689 200	d	3	1:125,000	Color	A
R8	Nelson River Basin (No. 10)	Pub. 1973	224 000	b	3	1:100,000	Color	A
R9	Fisher and Teulon (No. 12)	Pub. 1961	949 200	a,c	3	1:100,000	Color	A
R10	Swan River (No. 13)	Pub. 1962	316 000	a,c	3	1:125,000	Color	A
R11	South Eastern (No. 14)	Pub. 1964	749 200	a,c	3	1:125,000	Color	A,F
R12	Lac du Bonnet (No. 15)	Pub. 1967	764 800	a,c	3	1:125,000	Color	A,F,R
R13	Grahamdale (No. 16)	Pub. 1971	764 800	a,b	3	1:125,000	Color	A,F,U,R,E
R14	Red Rose-Washow Bay (No. 19)	Pub. 1975	704 400	a,b	3	1:125,000	Color	A,F

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1989

TABLE 1.

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
R15	Boissevain-Melita (No. 20)	Pub. 1978	299 520	a,b	2	1:40,000	Photo	A,I,E
R16	Ste. Rose (No. 21)	Pub. 1981	676 705	a,b	3	1:125,000	Color	A,I,R,E,F
R17	Waterhen (No. 23)	Pub. 1985	949 600	a,b	4	1:125,000	B&W	A,I,R,E,F
R18	Swan Lake	Data	599 200	a,b	3,4	1:125,000	B&W	A
R19	The Pas (No. 22)	Pub. 1982	791 700	a,b	4	1:125,000	Color	A,I,E,R,F
R20	Grand Rapids	Pre.	675 031	a,b	4	1:125,000	B&W	A
R21	Cormorant	Int. 1975	920 000	a,b	4	1:125,000	B&W	A
R22	Wekusko	Pre.	1 400 000	a,b	4	1:125,000	B&W	A
R23	Pointe du Bois	Pre.	740 000	a,b				
R25	Red Deer Lake	Pub. 1966	34 860	a,b	2	1:31,680	Photo	A
R26	Cross Lake and Norway House	Pre.	615 200	a,b	4	1:125,000	B&W	A
R28	Pasquia Lake	Pub. 1984	2 330	a,b	3	1:50,000	B&W	A,E
R29	Duck Mountain For. Reser.	Data	363 264	a,b,c	4	1:125,000	B&W	A,F,E,R,I

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1989

TABLE 1.

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
Biophysical and Exploratory Surveys								
B1	Lake Winnipeg, Churchill & Nelson Rivers	Pub. 1973	3 600 000	e	4	1:250,000 1:50,000	B&W	
B2	Churchill Transportation Corridor	Data 1974	179 000	f	4	1:125,000	B&W	
B3	54C Hayes River	Int. 1976	1 370 300	f	4	1:125,000	B&W	
B4	54D Kettle Rapids	Int. 1976	1 370 300		4	1:125,000	B&W	
B5	52M Carrol Lake	Int. 1977	634 000	f	4	1:125,000	B&W	
B5	62P Hecla	Int. 1977	466 200	f	4	1:125,000	B&W	
B6	53D Deer Lake	Int. 1978	629 700	f	4	1:125,000	B&W	
B6	63A Berens River	Int. 1978	848 500	f	4	1:125,000	B&W	
B7	53M Knee Lake	Int. 1978	1 405 900	f	4	1:125,000	B&W	
B8	53L Oxford House	Int. 1978	1 441 100	f	4	1:125,000	B&W	
B8	63H Norway House	Data	540 800	f	4	1:125,000	B&W	
B9	SE 1/4 64A Split Lake	Int. 1979	342 400	f	4	1:125,000	B&W	
B9	63P Sipiwesk	Int. 1979	1 405 900	f	4	1:125,000	B&W	
B10	53E Island Lake	Pre.	1 286 900	f	4	1:125,000	B&W	
B11	63H Norway House	Data				1:125,000	MSS	
E1	Surface Deposits & Soils of Northern Manitoba	Int. 1963		g	5	1:1,267,000	B&W	
E2	Exploratory Terrain Study of Northern Manitoba and Southern Keewatin, N.W.T.	Int. 1974		g	5	1:1,000,000	B&W	

1. Report Status
   Pub.-Published Report and Map
   Int.-Interim Report and Map Available
   Pre.-Preliminary Map and Legend Available
   Data-Field Data Available Only

2. Map Unit Descriptions Code
   a-single series and phases
   b-series complexes defined as to proportion
   c-series complexes undefined as to proportion
   d-associations
   e-biophysical units (materials and physiography)
   f-biophysical units (associations & complexes of associations)
   g-regional and local physiographic units

TABLE 1.

3.Survey Intensity Levels

Code	Name	Scale	Minimum Size Delineation(ha)	Inspection Density (Approx. range)
1	Very detailed	>1:12,000	<1.5	>1 per 3 ha
2	Detailed	1:12,000 to 1:40,000	1.5-16	1 per 3 to 50 ha
3	Semi-detailed	1:40,000 to 1:125,000	16 to 256	1 per 10 to 1 000 ha
4	Reconnaissance	1:125,000 to 1:250,000	256 to 625	1 per 100 to 110 000 ha
5	Exploratory	1:250,000 to 1:1,000,000	625 to 110 000	1 per 300 to 500 000 ha

4.Published Map Base Code

Photo-Photomosaic
B&W -Black and white line
Color-Colored line

5.Interpretations Code

A-Agriculture Capability
E-Engineering
F-Forestry
I-Irrigation Suitability
U-Urban Planning and Community Development
R-Recreation

TOTAL HECTARAGE COVERED

	1988	To Date
Initial Reconnaissance	12,800	19,271,010
Initial Detailed survey	779	18,793
Detailed Resurvey	97,792	3,381,257
Biophysical Survey	---	12,521,000

Published Reports, Maps, Interim Reports, available at a cost of $2.00 per copy (except for D20) from:

Queen's Printer,
Publications Branch,
Manitoba Archives Bldg.,
200 Vaughan St.,
Winnipeg, Manitoba R3C 1T5
Phone:945-3103

Detailed Surveys of Winnipeg Region and Brandon Region available at a cost of $6.00 each from:

Municipal Planning Branch
Manitoba Dept. of Municipal Affairs
1418-405 Broadway Ave.,
Winnipeg, Man., R3C 3L6
Phone: 945-2150

Biophysical Land Classification Maps and Reports available at a cost of $3.50 each from:

Surveys and Mapping Branch
Century Industrial Branch
989 Century Plaza
Winnipeg, Man., R3H 0W4
Phone: 945-6666

Preliminary Map and other field data available from:

Canada-Manitoba Soil Survey Office,
Rm. 362 Ellis Bldg., University of Manitoba
Winnipeg, Man., R3T 2N2
Phone: 474-6115 or 474-6118

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PART 1

GENERAL DESCRIPTION OF THE STUDY AREA

1.1 LOCATION AND EXTENT

The study area is comprised of five separate projects located to the west and southwest of the city of Winnipeg and covers an area of 6 300 hectares. The study includes soils in proximity to the towns of St. Eustache and Springstein in the Municipality of Cartier. In the Municipality of MacDonald to the south, the study involves a margin of land along the southwest perimeter highway, a band bordering the La Salle River between the towns of La Salle and Sanford and a small area adjacent to the town of Brunkild (Figure 1).

This study is a detailed resurvey of parts of a much larger area formerly covered in the reconnaissance soil survey of the Winnipeg Map Sheet Area (Soils Report No. 5, 1953). The current resurvey was carried out at a scale of 1:20,000 as opposed to the former reconnaissance survey at 1:125,000. A summary of the soil survey coverage for Manitoba is provided in Table 1.

1.2 LAND USE

Agriculture is undoubtedly the predominant land use throughout the study area. More specifically, grain farming with the growing of cereal crops along with flax, canola and sunflowers is most extensive. In the area around St. Eustache it is not unusual to find fields of potatoes, peas and cauliflower, particularly on the lighter alluvial soils. Mixed farming operations of cattle and grain are also found along the La Salle portion of the study.

The wooded fringe areas adjacent to Mill Creek and the La Salle River provide an excellent refuge for wildlife as well as an aesthetic break in the monotony of the level clay plain. These areas have very good potential for parks, preserves, paths and trails, etc.

The towns in the study are largely small agricultural trade and service centres which offer a variety of essential services including schools, churches, stores, agricultural supplies, banks, campgrounds, service stations, grain elevators etc. The Southwest Perimeter portion of the study has also attracted other major industries including gas storage facilities, a seed plant, lumber yards, a machinery dealership and a cement plant. These types of users are becoming increasingly significant considerations in making land use decisions, since they require substantial parcels of land.

1.3 GEOLOGY

The western part of the study area including St. Eustache, Springstein and Brunkild is underlain by dolomites of the Silurian Period. The La Salle River and Perimeter areas are represented by rocks of the Ordovician Period. These include shale, limestone and dolomite of the Stony

Mountain formation as well as dolomite and limestone of the Red River formation. The depth to bedrock in the study generally varies from 40 to 60 ft. (12 to 18 m), except in the vicinity of St. Eustache and Brunkild where it ranges up to 90 feet (27 m). Figure 2 shows the approximate location of the contacts between the bedrock formations and the overlying surface deposits.

1.4 RELIEF AND DRAINAGE

The principal relief and drainage features of the study area are shown in Figure(s) 3. The elevation of the study area ranges from approximately 750 f.a.s.l. (228 m) at La Salle to 800 f.a.s.l. (244 m) in the area of St. Eustache. Generally the study area may be described as having a level to nearly level surface expression with the most notable change in landscape being adjacent to the rivers and creeks of the area. The very gradual descending inclination of the entire study is from the west-northwest to east-southeast.

The surface drainage of the area is facilitated largely by the La Salle River and its contributory drains and ditches. The Brunkild area is drained by the Morris River. At Springstein there is a break in the drainage whereby some of the water moves north into the Assiniboine and the rest flows southward to the La Salle. The St. Eustache portion empties into Mill Creek as well as the headwaters of the La Salle. Generally the area depends to a large extent for its drainage on the man-made drainage channels which supplement and discharge into the natural streams. As a result of the flat topography and prevailing clay soils of the surface deposits, the natural streams were ineffective in providing adequate drainage of the land. Another significant aspect of the land drainage in the clay plain is that of micro-relief. Although the topography appears flat, slight depressions are common and result in the holding back or ponding of water from snow melt or after heavy rains. A typical example of some of these problems is in the Brunkild area where after heavy rainfall, standing water and crop damage often result. The La Salle River portion of the study, on the other hand, represents some of the better drained soils in the study.

1.5 PHYSIOGRAPHY

The distribution of physiographic divisions over the study area is shown in Figure 4. The entire project is within the Red River Plain section of the Manitoba Plain division. More specifically, the area is in the Red River Valley subsection which is classified as a level to nearly level lacustrine plain characterized by a combination of lacustrine, deltaic and fluvial deposits. It is a clay basin, with local floodplains and river levees, that occupies the flat depressional section which was covered by the deep waters of glacial Lake Agassiz.

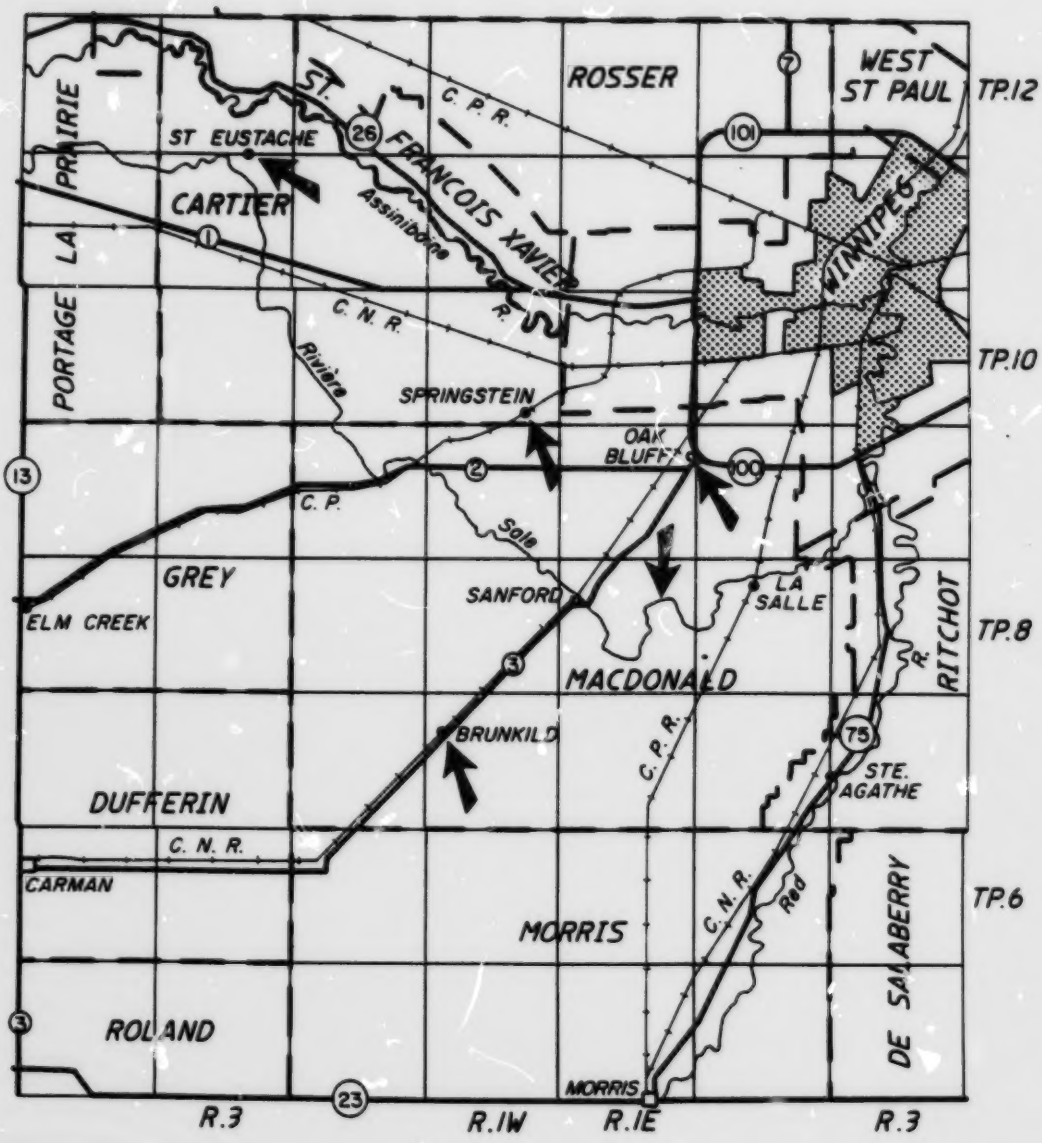
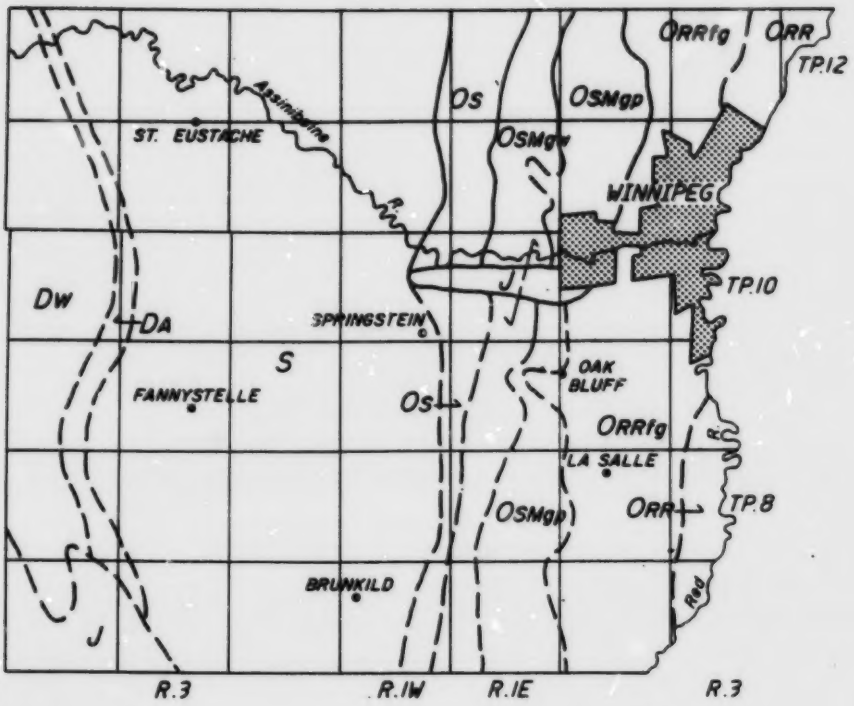


Figure 1: Location of Study Area.



MESOZOIC

Jurassic

J — Amaranth Formation: Red Argillaceous Dolomitic Siltstone and Sandstone Overlain by Gypsum or Anhydrite. Reston Formation: Limestone and Dolomite, Shale Interbeds. Melita Formation: Fine-Grained Sandstone, Variegated Shale, Minor Limestone.

PALEOZOIC

Middle Devonian

DA — Ashern Formation: Dolomitic Shale and Argillaceous Dolomite, Red to Greenish Grey; Local Basal Breccia.

DW — Elm Point Formation: High-Calcium Limestone Biomicrite. Winnipegosis Formation: Lower Member Dolomitized Platform Facies; Upper Member Thin Inter-reef Bituminous Laminates or Thick Reefal Carbonates.

Silurian

S — Interlake Group: Fisher Branch (FB), Inwood (I), Moose Lake (ML), Atikameg (A), East Arm (EA) and Cedar Lake (CL) Formations; Micritic, Fossiliferous, Stromatolitic and Biostromal Dolomites With Several Sandy/Argillaceous Marker Beds.

Ordovician

Os — Stonewall Formation: Dolomite, Fine-Grained, Sparsely Fossiliferous. In Part Conglomeratic.

Upper Ordovician

OSM dw gp — Stony Mountain Formation: Gunn and Penitentary Members (gp) – Calcareous Shale, Fossiliferous Limestone and Argillaceous Dolomite. Gunton and William Members (gw) – Nodular Dolomite, and Sandy Argillaceous Dolomite.

ORR fg — Red River Formation: Fort Garry Member (fg) – Massive to Laminated Dolomite; Minor Argillaceous Dolomite and High-Calcium Limestone; in Part Cherty.

Figure 2: Geology of Study Area.

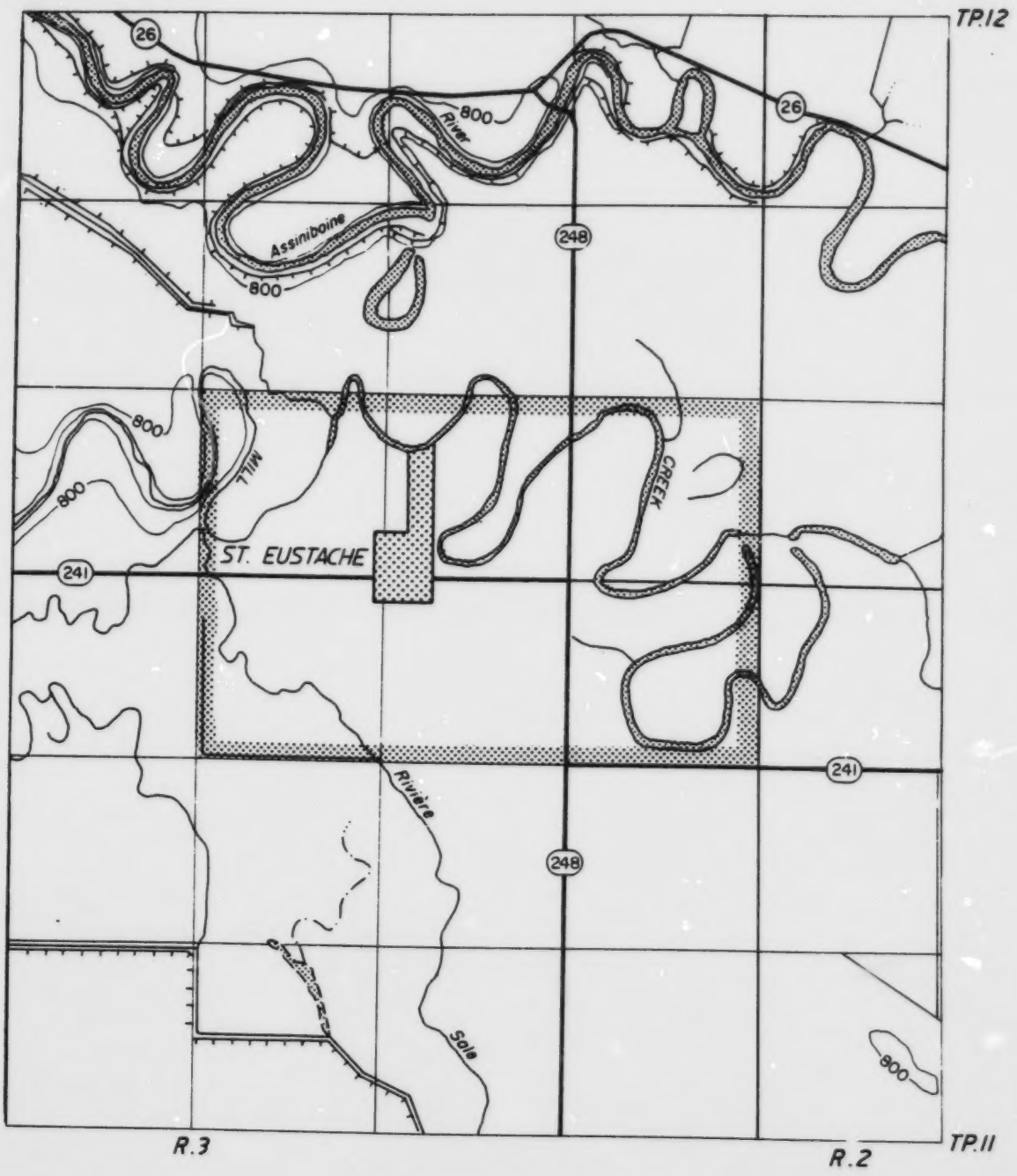


Figure 3a: Relief and Drainage of St. Eustache Area

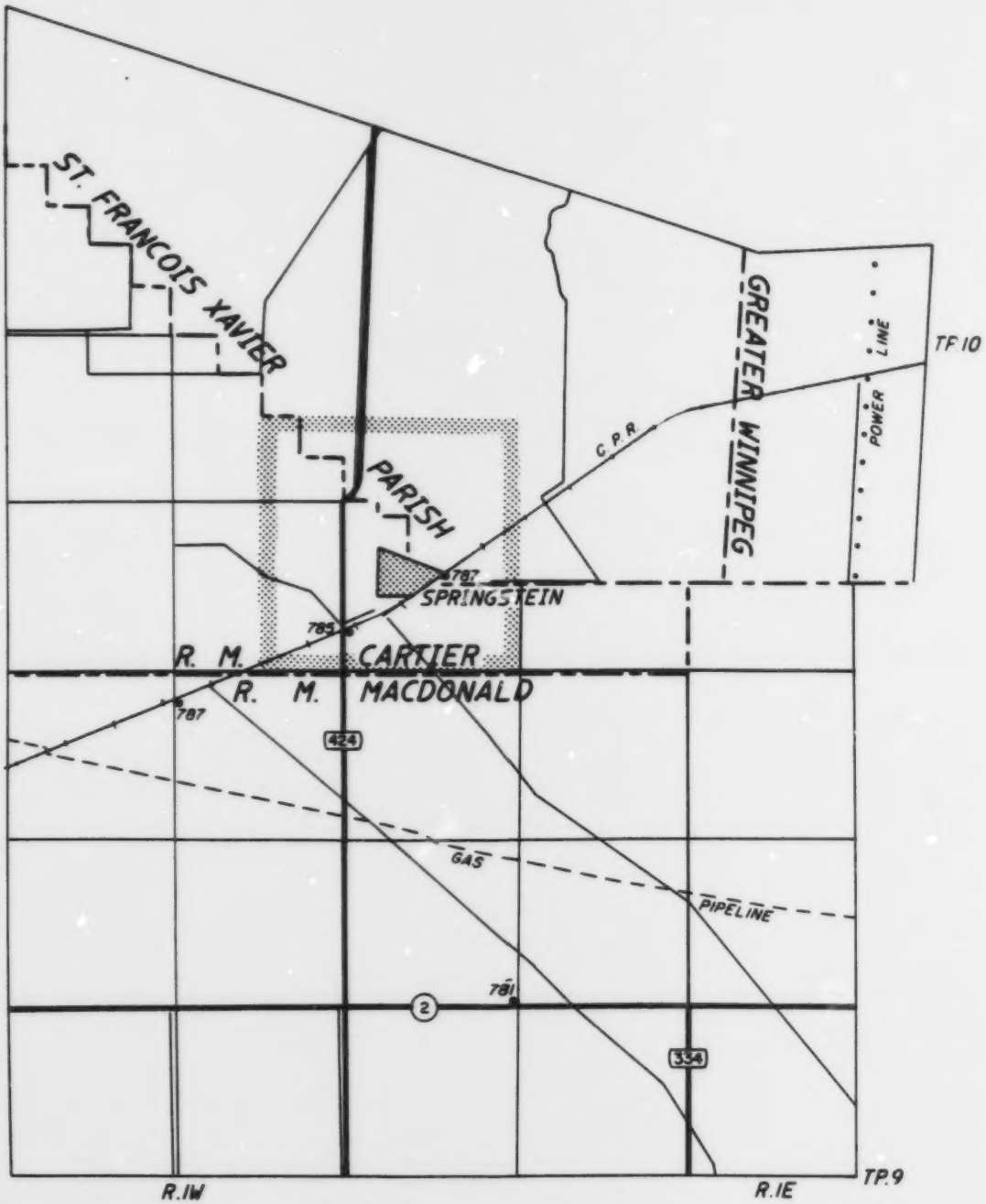


Figure 3b: Relief and Drainage of Springstein Area

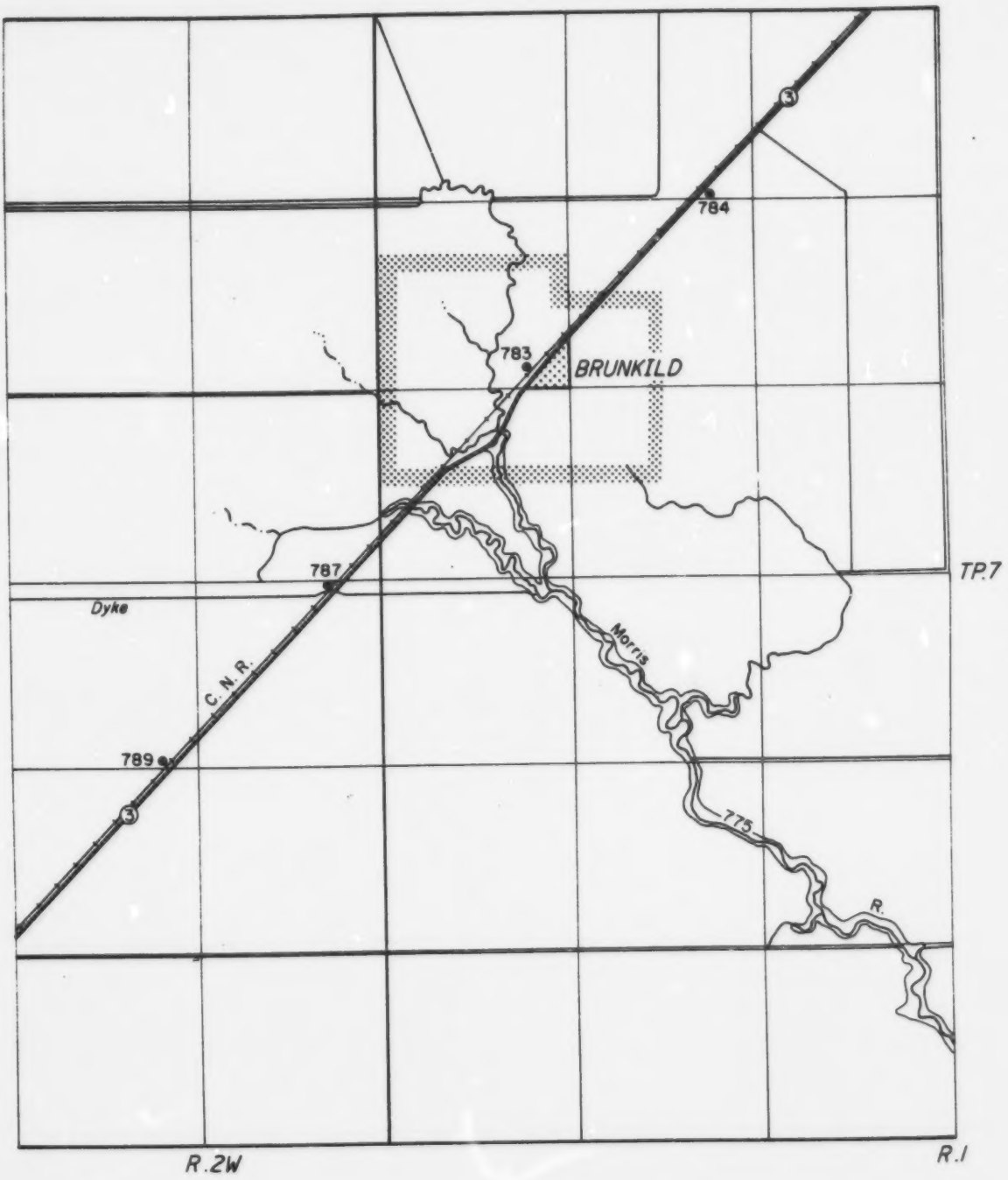


Figure 3c: Relief and Drainage of Brunkild Area

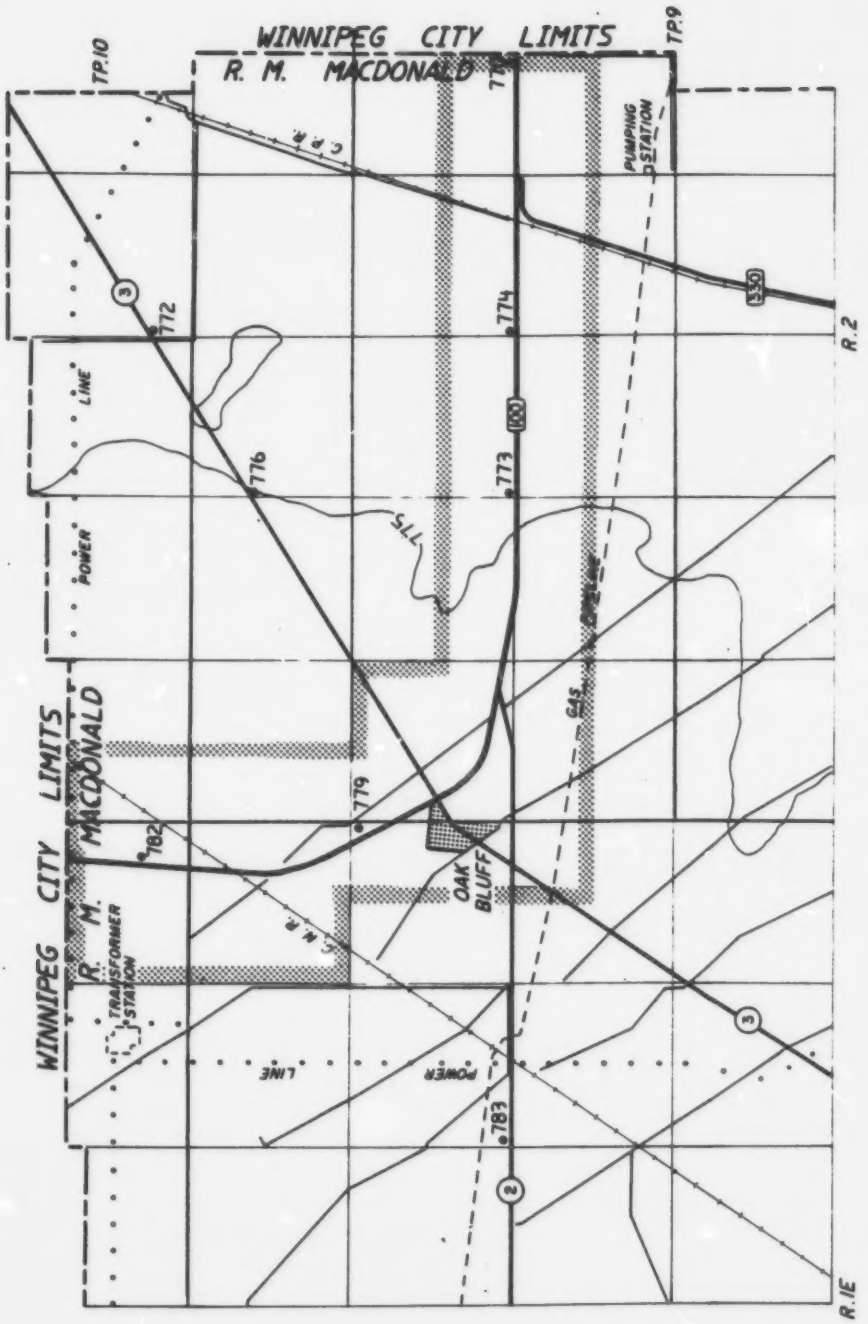


Figure 3d: Relief and Drainage of Southwest Perimeter Area

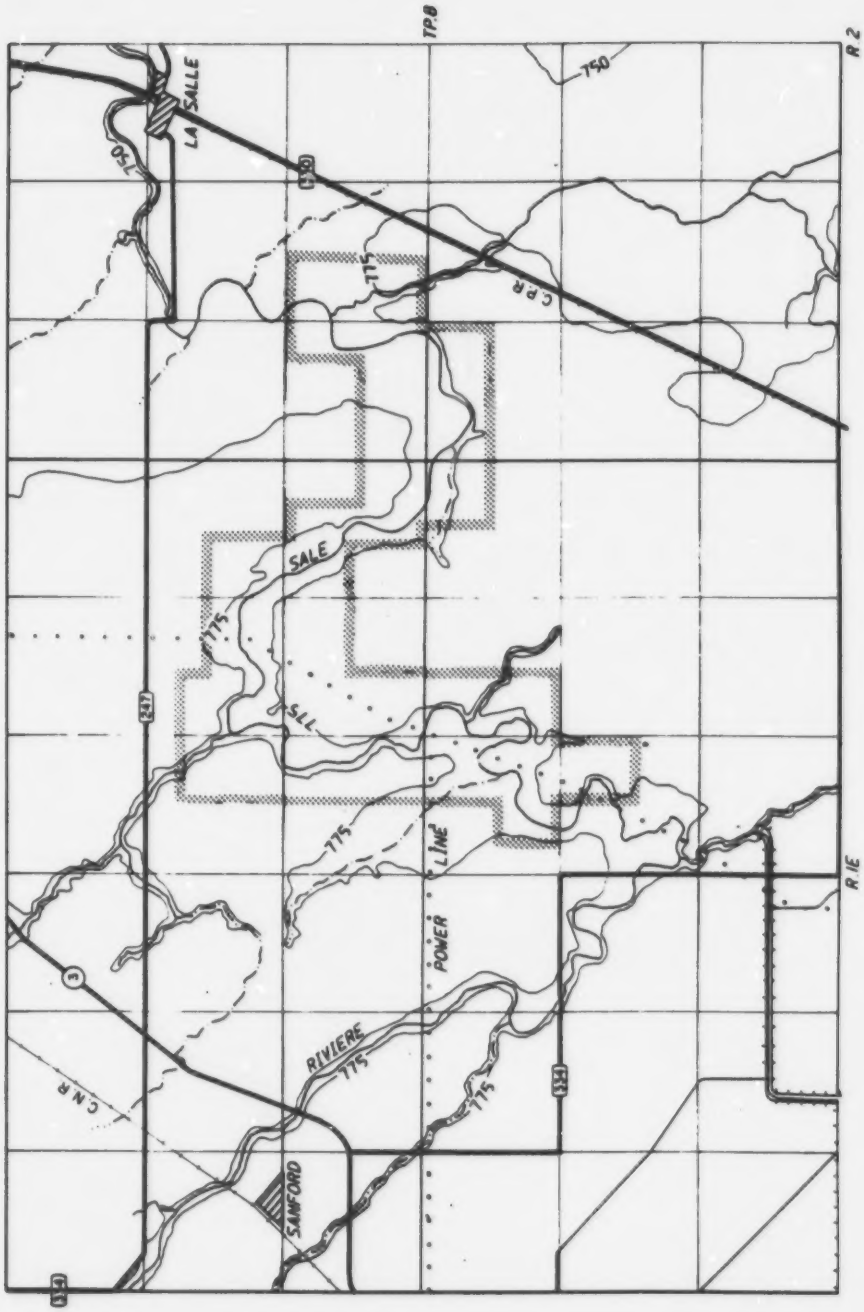


Figure 3e: Relief and Drainage of La Salle River Area

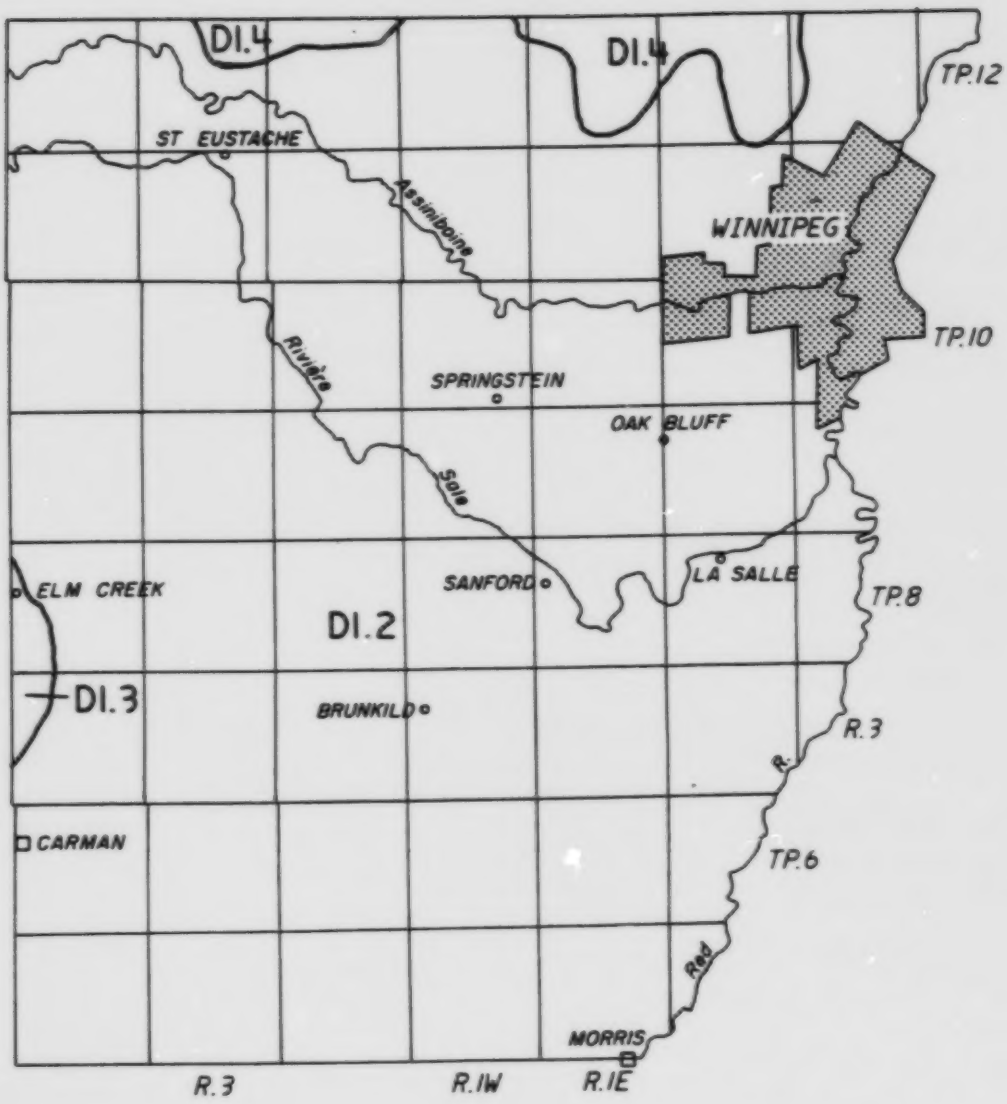


Figure 4: Physiographic Regions of the Study Area.

1.6 SURFACE DEPOSITS

The surficial deposits of the study area, which are underlain by carbonate rock, generally range in thickness from about 40 to 60[1] ft. (12 to 18 m), with expected fluctuations of up to 90 ft. (27 m). These surface materials consist of a 30 to 50 ft. (9-15 m) clay layer overlying glacial till. The thickness of the till deposit over bedrock may vary from approximately 10 to 20 ft. (3-6 m). The till is of a high lime nature derived mainly from limestone and granitic rocks.

The dominant near surface lacustrine sediments of the study area are mostly in the clayey particle size class. Some of the lacustrine clay soils in the St. Eustache area reflect more stratification with lighter (SiCL) layers. A noteworthy feature occurring in the Perimeter area of the study is the presence of "silt bars". These bars are typified by the occurrence of stratified silts within a metre of the surface in a dominantly clay soil.

Extensive areas of alluvial soils have been mapped along the La Salle River and Mill Creek, particularly in the St. Eustache section. These materials occur in the meander belts of the watercourses and may be up to 20 ft. (6 m) thick. The alluvium in the St. Eustache area consists of stratified (L-SiCL) textures with layers of fine sand, whereas in the La Salle River portion to the south the materials are somewhat heavier ranging from a clay loam to clay. The presence of sandy and loamy pockets in the meander belts consitute the only fresh water aquifers in the study. Since the potential for pollution of these aquifers is high, care must be taken to preserve this limited supply of fresh water. In times of high water levels, particularly spring runoff, these alluvial soils are most subject to flooding.

1.7 CLIMATE

Relative to worldwide climatic conditions, the study area is in the region designated as Dfb[2], subhumid, cool continental. Due to its location in the centre of the continent, a great distance from the moderating effect of the oceans, summer temperature are higher and winter temperatures are lower than the world average for the same latitude.

Within Manitoba the study area is considered to be dominantly within the Grassland Transition, Ecoclimatic Region, subregion 1 (Gt_1)[3] as shown in Figure 5. This subregion is characterized by a mean annual temperature of 2.0°C (0.8 to 3.1° range) with 1551. to 1908. degree days >5.0°C and an average of 116. (min 95 to mx. 130) frost free days. The average annual precipitation for this subregion ranges from 445 to 555 mm with a mean of 506 mm. The soil climate is described as having a mean annual temperature of 5.5 to <8.0°C with a mean summer soil tempterature of 12 to 16°C at the 50 cm depth. The soil moisture subclass is Subhumid with a cool Boreal to moderately cool Boreal temperature class.

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[1] Rutulis, M. Water Resources in the Winnipeg Region. 1973-74.

[2] Koppen, W. and Geiger, "Handbuck der Klimatologie" Bond L., Teil C., Gebruder Borntraeger, Berlin, 1936.

[3] Ecoclimatic Regions of Manitoba. Canada-Manitoba Soil Survey, Unpublished Data

A climate station[4] at Starbuck provides valuable site specific data representative of the study area. The average annual temperature is 2.4°C with July and August being the warmest months. The total annual precipitation is 533 mm with the wettest months being June at 84 mm and July at 75 mm. Records show the average frost-free period to be 114 days.

1.8 VEGETATION

The survey study intersects two major vegetative regions. The Brunkild and Springstein areas are in the Grassland Region whereas the St. Eustache, Perimeter and La Salle areas are dominantly in the Aspen-Oak Section of the Boreal Forest Region of Canada as delineated by Rowe[5]. However, when areas such as these share a major boundary, there is undoubtedly an overlap of regional characteristics.

The native vegetation on the smooth level plain was dominantly tall prairie and meadow-prairie grasses, but due to cultivation it has largely disappeared. Crops and windbreaks have replaced the native cover, except where fringes of bush consisting of aspen, oak, maple and shrubs such as hazel, dogwood and willow mark the meandering rivers and streams, field boundaries etc. Other species including elm, ash, basswood, cottonwood and elder with an undergrowth of ferns and allied herbaceous plants are confined to the alluvial deposits on the terraces and floodplains.

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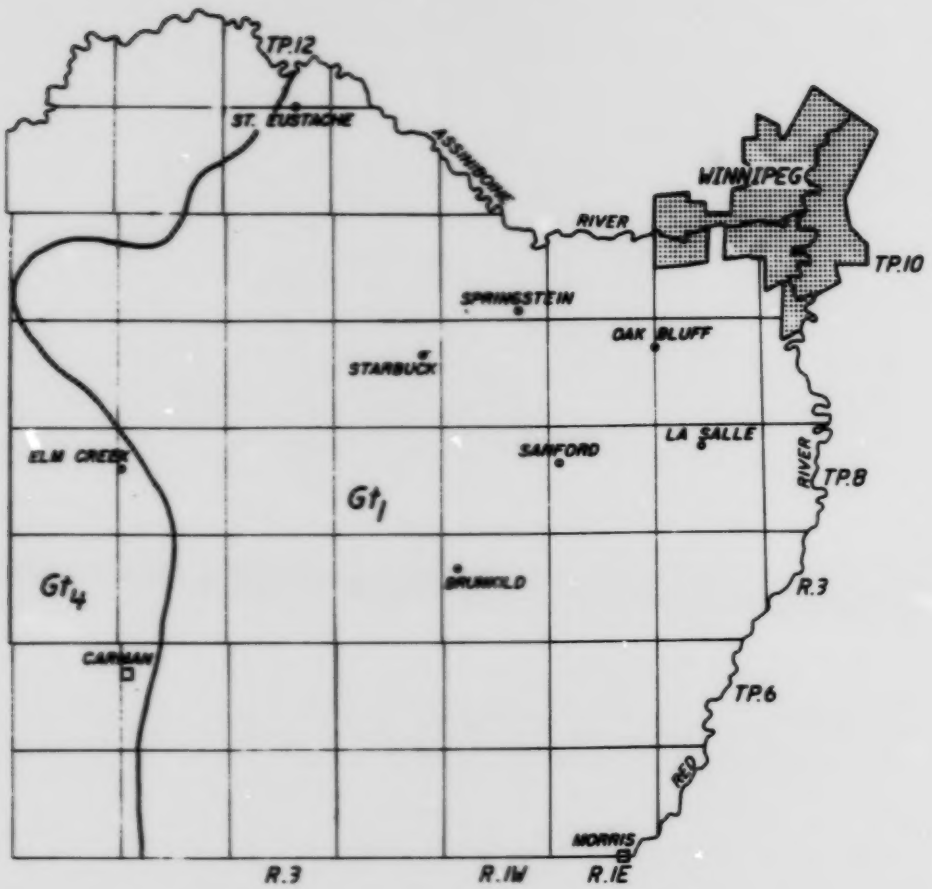
[4] Environment Canada, Canadian Climate Normals Volumes 2,3,4 and 6, 1951-1980.

[5] Rowe, J.S. 1972. Forest Regions of Canada, Publication No. 1300.



REGION NAME	SUBREGION SYMBOL	SOIL CLIMATE TEMPERATURE CLASS	SOIL CLIMATE MOISTURE SUBCLASS	DOMINANT SOIL ORDERS	VEGETATION ZONES
Grassland – transition	Gt_1	Cryoboreal, moderately cold to Boreal, cool	Subhumid	Chernozemic (Black) Gleysols	Grassland and Aspen Parkland
	Gt_4	Boreal, moderately cool	Subhumid	Chernozemic (Black) Gleysols	Grassland and Aspen Parkland

Figure 5: Ecoclimatic Regions of the Study Area.

PART 2

METHODOLOGY

2.1 MAPPING

Soil mapping in this project was conducted by soil surveyors employing an intensive grid or systematic sampling method. Soil profiles were examined to a depth of one meter at sites approximately 150 meters apart along foot traverses that, in turn, were spaced approximately 0.8 km apart. In this project, the initial inspection point in each section was located 50 to 100 meters from a road allowance fence approximately .4 km from a selected corner of the section to be surveyed. The direction each traverse took was determined on the basis of maximizing the information that could be derived from the range of known soil-landscape variation in each section. Additional sites along road allowances were also examined to help locate soil boundaries between sections. This method of sampling provided approximately 25 to 30 inspection sites per section, or put another way, each site represented approximately 8 to 10 ha. This intensity of sampling permitted the confident delineation of soil mapping units comprised of narrowly defined soil types and other landscape features such as slope, stoniness and erosion on maps at a scale of 1:20,000 (3 inches equal one mile).

2.2 MAP UNITS

A map unit[6] represents mappable portions of the soil landscape that together have characteristics and properties varying within more or less narrow limits that are determined by the intensity of the survey. A map unit contains predominantly one or more than one soil or nonsoil individual plus a certain proportion (varying within prescribed limits) of unnamed and undescribed inclusions. They are delineated on the basis of the types and relative proportions of their soils or nonsoils, as well as on the basis of external criteria such as slope, stoniness or erosion.

Soil maps show the distribution of kinds of soils and, as such, serve as a link so that the knowledge gained in one locality about the usefulness or behavior of a kind of soil can be extended to other bodies of the same soil.

A map unit comprises all delineations that contain exactly the same symbol. This includes all the characters denoting soils, nonsoils, phases and deciles. While they represent real portions of the landscapes, most map units are concepts

[6] A more complete description or definition is contained in the report: Mapping Systems Working Group. 1981. A Soil Mapping System for Canada: Revised. Land Resource Research Institute, Contribution No. 142, Agriculture Canada, Ottawa.

because their total range of properties is made up of the aggregate of all their delineations and no one delineation will contain the full range of properties. The proportions of each of the component soils and nonsoils and undescribed inclusions may vary within reasonable limits from one delineation to another.

A map unit is named from its principal component soils or nonsoils. It is described in terms of the properties of these components, their relative proportions and other external land attributes. In this project, units are described in terms of named soil series and phases of soil series. The soil series is defined as a naturally occurring soil body such that any profile within that body has a similar number and arrangement of horizons whose colour, texture, structure, consistence, reaction and composition are within a narrowly defined range.

Map units will always contain small proportions of inclusions. These inclusions may be soil or nonsoil mapping individuals that are named and have their own map units elsewhere in the survey, or they may be rare or insignificant soils or nonsoils that are not recognized and named at all in the survey. They may, however, be mentioned in the description of soil types in the report.

2.3 SIMPLE AND COMPOUND MAP UNITS

There are two major types of map units[7]: simple and compound. The difference between them is defined in terms of the proportion and contrast of their components.

A Simple Map Unit contains predominantly one soil or nonsoil. The proportion of its components vary according to their areal extent and contrasting characteristics as they may affect soil management or use. Its components vary as follows: the predominant component comprises at least 65 percent with up to 35 percent of nonlimiting, similar components (components are alike in most properties and behaviour), or up to 25 percent of nonlimiting dissimilar components (components do not affect management of the map unit but does have a significant number of properties that vary from the predominant to component), or up to 15 percent of limiting, dissimilar components (components have many constrasting properties and usually affect management differently).

A Compound Map Unit contains predominantly two soils or nonsoils (or a combination of both). The proportions of the two major components may vary from one considerably exceeding the other to both being approximately equal. Complementary to the definition of a single map unit, the proportions of its components vary according to their areal extent and contrasting characteristics as they may affect soil management or use. Its major components vary as follows: if other components are similar and nonlimiting no single component represents more than 65 percent; or if other components are dissimilar and nonlimiting no single component represents 75 percent or more; or if other components are dissimilar and limiting no single component represents 85 percent or more.

A soil or nonsoil may occur in more than one compound unit. The complex nature of soil landscapes requires that the surveyor be allowed

[7] See reference to the Soil Mapping System for Canada: Revised for a more complete description of mapping units.

the freedom to describe their combinations as they occur. For the purpose of describing compound map units, components are considered dominant if they occupy over 40 percent of the unit, significant from 15-40 percent and minor if they occupy less than 15 percent. Minor components are described only if they are highly contrasting.

2.4 PHASES

It is frequently desireable to indicate by map unit symbol, a condition or quality of soil property or landscape feature that deviates significantly from the normal definition of map units. These indicated variations or phases of soil properties and landscape features, varying from delineation to delineation, significantly affect soil behavior and land management or use.

It is not always easy to maintain a clear distinction between a soil phase and a land phase. Soil properties that are frequently used as phase criteria include texture depth, surface peat, salinity and physical disruption. Properties of land that are used include slope, wind and water erosion, stoniness, rockiness and altered drainage.

In this study the effect of four properties and land features are shown as a character in the denominator of the map unit symbol and described outside the main soil map legend. The four properties and features are erosion slope class, degree of stoniness and salinity. The degree or magnitude of each is designated in the following manner;

Erosion

x - noneroded or minimal
1 - weakly eroded
2 - moderately eroded
3 - severely eroded
O - overblown

Slope Class

x - 0 to 2% level to nearly level
c - 2 to 5% very gently sloping
d - 5 to 9% gently sloping
e - 9 to 15% moderately sloping
f - 15 to 30% strongly sloping
g - 30 to 45% very strongly sloping
h - 45 to 70% extremely sloping

Stoniness

x - nonstony
1 - slightly stony
2 - moderately stony
3 - very stony
4 - exceedingly stony
5 - excessively stony

Salinity

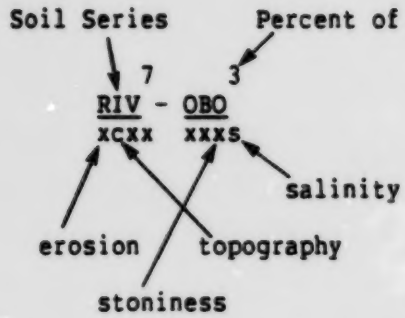
x - nonsaline (0-4 mS/cm)
s - slightly saline (4-8 mS/cm)
t - moderately saline (8-15 mS/cm)
u - strongly saline (>15 mS/cm)

The convention employed to indicate these features in the map symbol is as follows:

If none of the above properties are observed to be significant, the map symbol representing the normal or unaffected soil series is used alone without modifiers.

If one or more phase features are recognized, the appropriate letter or number is placed below the soil series symbol in one of four designated locations in the map unit symbol. The designated order is erosion, slope class, stoniness and salinity. If a particular feature is not observed to be significant, an x is used in its appropriate designated location in the map symbol.

For example, the compound map unit coded:



Is interpreted to mean that 70 percent of the mapping unit consists of Red River (RIV^{7}) series having no erosion (x), very gently sloping (c) topography, non (x) stony, no salinity (x): and 30 percent Osborne (OBO^{3}) series having no erosion (x), level (x) topography, nonstony (x) surface conditions and slightly (s) saline.

Definitions of the erosion, topography, stoniness and salinity classes are given in the Glossary.

2.5 SAMPLING

During the course of field investigations and mapping, soil samples were taken at selected locations for soil characterization, salinity and irrigation suitability studies. Four profiles were described in detail and sampled for soil characterization analysis (Appendix F). In areas where salinity was suspected to be a problem soils were sampled at 10 to 25 cm and at 50 to 60 cm for electrical conductance measurements and soluble salt analysis.

PART 3

FORMATION, CLASSIFICATION AND MORPHOLOGY OF SOILS

3.1 SOIL DEVELOPMENT

The principal factors affecting soil formation are climate, vegetation, parent material, relief and drainage. The type of soil formed at any one place is dependent upon the interaction of these factors, the length of time they have been operative, and the influence of human activity.

In the study area, the degree of soil development is related to the regional climate which affects the degree of leaching, translocation and accumulation of soluble and colloidal fractions of the soil. Soil development has taken place under a moderately cool to cool, subhumid Boreal climate which has produced growing conditions conducive to the establishment of tall prairie grasses, meadow grasses, aspen-oak fringes and associated grassland vegetation. Under these conditions the amount of water available for leaching is relatively low, but sufficient to support grassland vegetation, this results in accumulation of organic matter in the mineral surface horizons and gives the soils the "black color". A majority of the soils developed in the study area are Chernozemic Blacks under well to imperfectly drained conditions and Humic Gleysols in the poorly drained areas. Local areas of Dark Gray soils have been mapped, mainly along the La Salle River where woodland invasion has developed. The vegetation on these soils is dominantly oak with some aspen and has resulted in a greater degree of leaching and translocation of soluble and colloidal fractions. Cumulic Regosols of relatively youthful origin have developed on the floodplains and levees in areas adjacent to the major rivers and streams in the study area.

Saline phases of various soils have been mapped at St. Eustache and Springstein. These salt affected soils exhibit numerous adverse characteristics including crop sensitivity and poor structure.

3.2 SOIL SERIES DESCRIPTIONS

Soil series for the study area are described in alphabetical order and include a general description of the genetic profile type, texture, parent material, topography and drainage. General statements on the distribution, surface runoff, stoniness and vegetation characteristics are also given. For additional information and discussion relative to soils of the area, particularly chemical and physical soil analyses refer to the "Soils of the Winnipeg Region Study Area" Report No. D14, 1975. A convenient, abbreviated key form of reference on the relationship of soil series in the study to soil drainage, subgroup and parent material is provided in Table 2. A more comprehensive grouping of soils and parent materials is presented in Table 3.

Table 2. Soil Series of the Study Area arranged in Relation to Soil Moisture Class, Subgroup and Parent Material.

Soil Moisture Class	Subgroup	Parent Materials							
		Lacustrine (Gt_1)		Alluvium (Gt_1)		Lacustrine (Gt_4)	Alluvium (Gt_4)		
		Clayey (C,SiC)	Clayey over Loamy (C,SiC/Si,SiL,SiCL)	Clayey (C,SiC,SiCL) Stratified	Loamy (L,SiL,SCL,CL,SiCL) Stratified	Clayey (C,SiC,SC) Stratified,Subsoil	Loamy (L,SiL,SiCL,CL)	Clayey (C,SiC,SC)	Fine Loamy/Clayey (L,CL,SiCL/C,SiC)
Well	Cumulic Regosol Orthic Black Orthic Dark Gray	Myrtle(MYT) St. Norbert(SOR)	Fort Garry(FTY)	Black Lake(BCK)	Hodgson(HDG)				
Imperfect	Gleyed Cumulic Regosol Gleyed Black Gleyed Rego Black	Scanterbury(SCY) Red River(RIV)	Dencross(DCS)	Seine River(SRE)		Plum Coulee(PME) Deadhorse(DHO)	Gervais(GVS)	Fortier(FTE)	Pigeon Lake(PGK)
Poor	Rego Humic Gleysol	Osborne(OBO)	Glenmoor(GOO)	Dufresne(DFS)			Willowbend(WWB)		

TABLE 3

Parent Materials and Related Soils of the Study Area

A. Lacustrine Materials

1. Soils developed on deep (>1 m), moderately to strongly calcareous, clayey (C,SiC) lacustrine sediments. (Gt_1)

   a) Well drained

      • Myrtle series (Orthic Black) — MYT

      • St. Norbert series (Orthic Dark Gray) — SOR

   b) Imperfectly drained

      • Scanterbury series (Gleyed Black) — SCY

      • Red River series (Gleyed Rego Black) — RIV

   c) Poorly drained

      • Osborne series (Rego Humic Gleysol) — OBO

2. Soils developed on a thin mantle (<1 m) of moderately to strongly calcareous, clayey sediments over very strongly calcareous, loamy (Si,SiL, SiCL) materials. These deposits are generally underlain by lacustrine clay at about one metre. (Gt_1)

   a) Well Drained

      • Fort Garry series (Orthic Black) — FTY

   b) Imperfectly drained

      • Dencross series (Gleyed Rego Black) — DCS

   c) Poorly drained

      • Glenmoor series (Rego Humic Gleysol) — GOO

3. Soils developed on clayey (C,SiC,SC), moderately to strongly calcareous lacustrine sediments, having a stratified subsoil. (Gt_4)

   a) Imperfectly drained

      • Plum Coulee series (Gleyed Black) — PME

      • Deadhorse series (Gleyed Rego Black) — DHO

B. Alluvial Materials

1. Soils developed on moderately to strongly calcareous, clayey (C,SiC,SiCL), stratified, recent alluvial deposits. (Gt_1)

   a) Well drained

      • Black Lake series (Cumulic Regosol) BCK

   b) Imperfectly drained

      • Seine River series (Gleyed Cumulic Regosol) SRE

   c) Poorly drained

      • Dufresne series (Rego Humic Gleysol) DFS

2. Soils developed on moderately to strongly calcareous, stratified, loamy (L,SiL,SiCL,CL) recent alluvial deposits. (Gt_1)

   a) Well drained

      • Hodgson series (Cumulic Regosol) HDG

3. Soils developed on moderately to strongly calcareous, stratified, loamy (SL,L,SiL,SiCL,CL) recent alluvial deposits. (Gt_4)

   a) Imperfectly drained

      • Gervais series (Gleyed Cumulic Regosol) GVS

   b) Poorly drained

      • Willowbend series (Rego Humic Gleysol) WWB

4. Soils developed on moderately to strongly calcareous, clayey (C,SiC,SC), stratified recent alluvial deposits. (Gt_4)

   a) Imperfectly drained

      • Fortier series (Gleyed Cumulic Regosol) FTE

5. Soils developed on thin (<1 m), moderately to strongly calcareous, fine loamy (L,CL,SiCL), recent fluvial sediments overlying clayey (C,SiC) lacustrine sediments. (Gt_4)

   a) Imperfectly drained

      • Pigeon Lake series (Gleyed Cumulic Regosol) PGK

Black Lake Series (BCK)

The Black Lake series consists of a well drained Cumulic Regosol soil developed on moderately to strongly calcareous, deep stratified, clayey, fluvial deposits. These soils occur in upper positions of gentle slopes on terrace landscapes and have moderately slow permeability, moderate surface runoff and a low to medium water table during the growing season. Black Lake soils are noneroded, nonstony and nonsaline. They have medium to high available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes elm, maple, box elder, cottonwood and some oak. The majority of these soils are currently used for agriculture or are in their native treed state and are subject to flooding.

In a representative profile of Black Lake soil the solum is approximately 15 cm thick. The profile is characterized by a gray, weakly calcareous, SiC, Ah horizon, 0 to 15 cm thick, with a gray (10YR 5/1d), weakly calcareous, SiC, Ck1 horizon, 15 to 30 cm, a gray to light gray, mod. calcareous, SiC, Ck2 horizon, 30 to 50 cm with SiL to SiCL strata and a brownish gray, mod. calcareous, SiC, Ck3 horizon 50 to 90 cm. The parent material is typically stratified.

Black Lake soils occur in close association with Seine River and Hodgson soils. They are similar to Hodgson soils by having a similar position and mode of deposition but differ from Hodgson soils because of a heavier texture. Black Lake soils were previously mapped as Riverdale in the Winnipeg Map Sheet, Report No. 5, 1953.

Deadhorse Series (DHO)

The Deadhorse series consists of an imperfectly drained Gleyed Rego Black soil developed on moderately to strongly calcareous, deep, stratified, clayey, lacustrine deposits. These soils occur on low to middle positions of level to gentle slopes on level landscapes and have moderately slow-slow permeability, slow surface runoff and a medium water table during the growing season. Deadhorse soils are noneroded, nonstony and may be saline. They have medium to high available water holding capacity, medium organic matter content, and medium natural fertility. The majority of these soils are currently used for crop production.

In a representative profile of the Deadhorse soil the solum is approximately 35 cm thick. The profile is characterized by a very dark gray, clay Ah horizon, 15 to 25 cm thick, a carbonated, gray to dark gray, clay, ACk horizon, 8 to 20 cm thick and a moderately to strongly calcareous, weakly mottled Ckgj horizon, with a stratified clay to silty clay loam texture. The parent material is typically clayey with stratified (CL to SiL) layers, and moderately to strongly calcareous. A typical profile also contains the occassional bured Ah horizon below 60 cm.

Deadhorse soils occur in close association with Plum Coulee, Dugas and Red River soils. They are similar to Plum Coulee and Dugas soils by having a stratified subsoil but differ from Red River soils which have considerably less stratification in the subsoil, a key difference. Deadhorse soils were previously mapped as Oakville soils in the Winnipeg Map Sheet Area (Report No. 5, 1953).

Dencross Series (DCS)

The Dencross series consists of imperfectly drained Gleyed Rego Black soils developed on (<1 m) of moderately to strongly calcareous, shallow clayey, lacustrine, deposits over very strongly to extremely calcareous, silty, lacustrine deposits. These soils occur in mid to upper positions of level to very gentle slopes on level to undulating landscapes and have slow to moderate permeability, slow surface runoff and a medium water table during the growing season. Dencross soils are none to slightly eroded, none stony and may be saline. They have medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes prairie grasses, aspen and willow. The majority of these soils are currently used for crop production.

In a representative profile of Dencross soil the solum is approximately 40 cm thick. The profile is characterized by a thin, very dark gray, clay Ah horizon, 15 to 25 cm thick; a moderately calcareous, dark gray, clay, ACk horizon, 15 to 20 cm thick; a light gray, clay to silty clay, mod. calcareous, Ckgj horizon, 20 to 30 cm thick and a light olive brown, very strongly calcareous, SiL-SiCL, 2Ckgj horizon. The parent material is typically clayey over silty. A typical profile also contains an underlay of clay below the silty strata at or below 1 m.

Dencross soils occur in close association with Hoddinott and Red River soils. They are similar to Hoddinott soils by having a silty subsoil but differ from Red River soils which are more uniformly clayey throughout. Dencross soils were previously mapped as Fort Garry Association in the Winnipeg Map Sheet (Report No. 5, 1953).

An example profile of a Dencross soil is presented in Appendix F.

Dufresne Series (DFS)

The Dufresne series consists of poorly drained Rego Humic Gleysol soils developed on strongly calcareous, deep stratified, clayey, alluvial deposits. These soils occur in low to depressional positions along stream channels and have slow permeability, very slow surface runoff and a high water table during the growing season. Dufresne soils are noneroded, nonstony and nonsaline. They have med.-high available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes sedge, rush and willow. The majority of these soils are currently used for natural grazing and woodland.

In a representative profile of Dufresne soil the solum is approximately 20 cm thick. The profile is characterized by a thin, dark gray, clay, Ah horizon, 15 to 25 cm thick, with a variable, stratified, strongly calcareous, clay to silty clay mottled Ckg horizon with thin former Ah (buried) horizons in the stratified layers. The parent material is typically stratified clayey.

Dufresne soils occur in close association with Seine River soils. They are similar to Seine River soils by having similar textures but differ because of having poorer drainage. Dufresne soils were previously mapped as Riverdale soils in the Winnipeg Map Sheet (Report No. 5, 1953).

Fortier Series (FTR)

The Fortier series is a Gleyed Cumulic Regosol soil developed on imperfectly drained, moderately to strongly calcareous, clayey (SiC, C) fluvial sediments. These soils occur on smooth, level topography in association with Willowbend, Gervais and La Salle soils. Periodic overflow or ponding occurs with spring runoff or during periods of high rainfall. Surface runoff is slow. Permeability is slow due to the clay textures and downward movement can be restricted by a high water table, especially in spring. Although most Fortier soils are cultivated, small remnant stands of native vegetation support tall prairie and prairie-meadow grasses with some deciduous trees.

The Fortier soil profile has a weak, dark gray to gray Ah horizon, 10 to 20 cm thick which is slightly darker in color than the underlying mottled C horizon. Thin layers of very fine sandy loam, silt loam and silty clay loam are often present in the dominantly clayey profile. Buried Ah horizons occur in profiles in some areas. Fortier soils are finer textured and less permeable than the coarser textured Gervais soils.

These soils have moderate agricultural limitations due to wetness and the possibility of seasonal inundation. Fortier soils take longer to warm up in spring and take longer to become trafficable after rain than coarser textured soils.

Gervais Series (GVS)

The Gervais series consists of imperfectly drained Gleyed Cumulic Regosol soil developed on moderately to strongly calcareous, deep, stratified, loamy (SiL,L,SiCL,CL), recent fluvial deposits. Flooding is a hazard where drainage has not been improved. These soils occur in middle positions of very gentle slopes on floodplain landscapes and have moderately slow to slow permeability, slow surface runoff, and a high water table during the growing season. Gervais soils are noneroded, nonstony, and nonsaline. They have medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation includes elm, maple, poplar and meadow grasses. The majority of these soils are currently cultivated for crop production.

In a representative profile of Gervais soil there is no solum development. The profile is characterized by a weakly developed dark gray to gray Ah horizon, 12 to 20 cm thick, and a lighter colored Ck horizon, with stratified FSL and FS textured layers. A typical profile also contains dark coloured buried Ah horizons.

Gervais soils occur in close association with La Salle, and Willowbend soils. They are similar to Poplar Point soils by having an imperfectly drained profile in loamy deposits but differ from them in having a distinct Ah horizon. Gervais soils were previously mapped as associates of the Riverdale Association in the Winnipeg Map Sheet (Report No. 5, 1953).

Glenmoor (GOO)

The Glenmoor series consists of poorly drained Rego Humic Gleysol soil developed on a thin mantle (<1 m) of moderately to strongly calcareous, clayey lacustrine deposits over very strongly to extremely calcareous, silty, lacustrine deposits. An underlay of lacustrine clay generally occurs at or below 1m. These soils occur in low to depressional positions of level to very gentle slopes

on nearly level landscapes and have slow to moderate permeability, very slow surface runoff and a high water table during the growing season. Glenmoor soils are noneroded, nonstony and may be saline. They have medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes sedges, grasses and willow. The majority of these soils are currently used for cultivation with adequate drainage.

In a representative profile of the Glenmoor soil the solum is approximately 10 to 25 cm thick. The profile is characterized by a thin, very dark gray, clay Ah(Ap) horizon, 0 to 22 cm, with a moderately calcareous, olive gray, clay Ckg horizon, 22 to 45 cm and a pale olive to olive, very strongly to extremely calcareous, Sil-SiCL, mottled, 2Ckg horizon. The parent material is typically clayey over silty. A typical profile also contains a clayey substrate below the silty sediments at or below 1 m.

Glenmoor soils occur in close association with Dencross soils. They are similar to Dencross soils by having similar materials but differ because of poorer drainage. Glenmoor soils were previously mapped as part of the Fort Garry association in the Winnipeg Map Sheet (Report No. 5, 1953).

Hodgson Series (HDG)

The Hodgson series consists of a well drained Cumulic Regosol soil developed on mod. to strongly calcareous, deep, somewhat stratified, loamy, alluvial deposits. These soils occur in upper slope positions of floodplains and levees and have mod. to slow permeability, moderate surface runoff and a med. to low water table during the growing season. Hodgson soils are noneroded, nonstony and nonsaline. They have medium available water holding capacity, medium organic matter content, and med. natural fertility. Native vegetation often includes elm, ash, basswood and maple. The majority of these soils are currently used for agriculture and native woodland.

In a representative profile of the Hodgson soil the solum is approximately 15 cm thick. The profile is characterized by a dark gray to gray, none to weakly calcareous, SiCL, Ah horizon, 0 to 15 cm, with a light browish gray, mod. to strongly calcareous, stratified, SiL to SiCL, Ck horizon, containing dark colored bands representing fomer surface layers or horizons. The parent material is typically stratified, L-SiCL and mod. to strongly calcareous. A typical profile also contains buried horizons.

Hodgson soils occur in close association with Fisher, Seine River and Black Lake soils. They are similar to Black Lake soils by having developed an alluvial deposits and being well drained but differ because of being lighter textured. Hodgson soils were previously mapped as the Riverdale association in the Winnipeg and Morris Map Sheets, Report No. 5, 1953.

Myrtle Series (MYT)

The Myrtle series consists of well drained Orthic Black soil developed on moderately to strongly calcareous, deep, uniform clayey, lacustrine deposits. These soils occur in upper slope positions of nearly level to very gently slopes on level landscapes and have slow to moderate permeability, moderate surface runoff and a medium water table during the growing season. Myrtle soils are noneroded, nonstony and nonsaline.

They have medium available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes oak, maple, aspen and grasses. The majority of these soils are currently used for crop production.

In a representative profile of the Myrtle soil the solum is approximately 55 cm thick. The profile is characterized by a deep, very dark gray, non calcareous clay Ah horizon, 30 to 35 cm thick, with a dark brown, noncalcareous, clay, Bm horizon, 25 to 35 cm thick, and a pale brown to yellowish brown, strongly calcareous, clay Ckgj horizon. The parent material is typically a uniform clay.

Myrtle soils occur in close association with Scanterbury and Red River soils. They are similar to these soils by having the same parent material but differ because of drainage and solum depth. Myrtle soils were previously mapped as Red River in the Winnipeg Map Sheet (Report No. 5, 1953).

Osborne Series (OBO)

The Osborne series consists of poorly drained Rego Humic Gleysol soils developed on moderately to strongly calcareous, deep uniform, clayey, lacustrine deposits. These soils occur in lower to depressional positions of level to nearly level slopes on level landscapes and have very slow permeability, slow to very slow surface runoff and a high water table during the growing season. Osborne soils are none eroded, none stony and may be saline. They have high available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes meadow grasses, reeds, sedges and willow. The majority of these soils are currently used for crop production and have improved drainage.

In a representative profile of Osborne soil the solum is approximately 30 cm thick. The profile is characterized by a very dark gray, noncalcareous, clay, Ap horizon, 15 to 20 cm thick, with a thin transitional, dark gray to olive gray weakly calcareous AC horizon, 8 to 10 cm thick and an olive gray, moderately to strongly calcareous, clayey, mottled Ckg horizon. The parent material is typically a uniform clayey lacustrine deposit.

Osborne soils occur in close association with Red River, Morris and Scanterbury soils. They are similar to these soils by having developed on the same parent material but differ because of poorer drainage. Osborne soils were previously mapped as Osborne clay in the Winnipeg Map Sheet (Report No. 5, 1953).

Pigeon Lake Series (PGK)

The Pigeon Lake series is a Gleyed Cumulic Regosol developed on imperfectly drained, shallow (<1 meter), moderately to strongly calcareous, loamy (SiL, L, SiCL, CL), recent fluvial sediments overlying clayey (SiC, C), lacustrine and fluvial sediments. These soils occur in the western portion of the Red River Plain in proximity to the Assiniboine, Elm, La Salle and Boyne Rivers on level to very gently sloping topography. Pigeon Lake soils are situated in a transition area between deep, loamy, recent fluvial deposits such as La Salle or Gervais soils, and clayey, lacustrine deposits such as the Red River or Scanterbury soils. Surface runoff is moderately slow to slow. Permeability is moderate to moderately slow in the upper loamy sediments, and slow in the clayey sediments. Inundation and periodic flooding are

common during periods of rapid or excess snowmelt. Most of these soils have been cultivated. Tall prairie grasses and deciduous trees occur in small, remnant stands of native vegetation.

Plum Coulee Series (PMR)

The Plum Coulee series is a Gleyed Black soil developed on imperfectly drained, moderately calcareous, stratified, clayey (SiC, C), fluvial and lacustrine sediments. These soils occur in the western part of the Red River Plain on level to very gently sloping topography, in association with Winkler and Deadhorse soils. Surface runoff is moderately slow, and permeability is slow. Most of these soils are cleared and under cultivation. Native vegetation consists of tall prairie and prairie-meadow grasses.

The Plum Coulee soil profile has a firm to friable, very dark Ah horizon, 13 to 25 cm thick; a dark gray to dark grayish brown Bmgj horizon, 15 to 30 cm thick with compound weak, medium prismatic and moderate, medium granular structure. Faint mottles are apparent in the lower B horizon and are more noticeable with increasing depth. The mottled Ckgj horizon is usually stratified with dominantly clay textures. Gypsum crystals also occur in the C horizon. This soil differs from the very similar Deadhorse soil in having a prominent Bmgj horizon.

Red River Series (RIV)

The Red River series consists of imperfectly drained Gleyed Rego Black soils developed on moderately to strongly calcareous, deep, uniform, clayey, lacustrine deposits. These soils occur in level to upper positions of level to very gentle slopes on level landscapes and have slow permeability, slow to moderate surface runoff and a medium water table during the growing season. Red River soils are noneroded, nonstony and may be saline. They have medium to high available water holding capacity, medium organic matter content, and medium natural fertility. The majority of these soils are currently used for crop production.

In a representative profile of Red River soil the solum is approximately 30 cm thick. The profile is characterized by a black, to very dark gray clayey Ap horizon, 15 to 20 cm thick, a very dark gray, clayey Ah horizon, 8 to 10 cm thick which frequently tongues well into the C horizon, a thin, dark gray, calcareous, clay, ACkgj horizon, 6 to 10 cm thick and a dark grayish brown, calcareous, clay Ckgj horizon with faint mottles. The parent material is typically a uniform clay. A typical profile contains frequent tonguing of the A horizon into the C horizon.

Red River soils occur in very close association with Scanterbury, Morris and Osborne soils. They are similar to the above soils by having developed on the same parent material but differ because of drainage and profile development. Red River soils were previously mapped as the Red River Association in the Winnipeg Map Sheet, Report No. 5, 1953.

An example profile of a Red River soil is presented in Appendix F.

Scanterbury Series (SCY)

The Scanterbury series is a Gleyed Black soil developed on imperfectly drained, moderately to strongly calcareous, clayey (SiC, C, HC), lacustrine deposits. These soils occur on level to very gently sloping topogra-

phy in the Red River Plain in association with Red River, Morris and Osborne soils. Surface runoff is slow and permeability is very slow. The tall prairie and prairie-meadow grasses once found associated with these soils have been mostly replaced by cultivated fields.

The Scanterbury soil profile has a very dark gray Ah horizon, 15 to 30 cm thick, that frequently tongues through the B horizon; a very dark gray to dark grayish brown Bmgj horizon, 12 to 40 cm thick; a very dark gray sh brown BC, 10 to 15 cm thick, and an olive gray calcareous Ckgj horizon with many, fine, faint mottles.

This soil differs from the similar Plum Coulee soil series in having more uniform textures in the subsoil. It differs from Red River soils in having a prominent Bmgj horizon. Scanterbury, Red River and Morris soils are usually found together in such close and intricate association with each other that it is difficult to not find all three together in the same field in areas where they normally occur.

St. Norbert Series (SOR)

The St. Norbert series consists of a well drained Orthic Dark Gray soils developed on moderately calcareous, deep uniform, clayey, lacustrine deposits. These soils occur in upper positions of nearly level to very gentle slopes on level landscapes and have mod. slow to slow permeability, moderate surface runoff and a low to medium water table during the growing season. St. Norbert soils are none eroded, none stony and none saline. They have med. to high available water holding capacity, medium organic matter content, and medium natural fertility. Native vegetation often includes bur oak, maple, elm, aspen and grasses. The majority of these soils are currently used for agriculture and native woodland along rivers and streams.

In a representative profile of the St. Norbert soil the solum is approximately 60 cm thick. The profile is characterized by a partially decomposed LH horizon, 3 to 0 cm, a dark gray, noncalcareous, clay, Ahe horizon, 0 to 18 cm, a thick, dark gray to dark grayish brown, noncalcareous, prismatic, clay Bt or Btj horizon, 18 to 60 cm, and a dark grayish brown, moderately calcareous, massive Ckgj horizon 60 to 100 cm. The parent material is typically clayey and weakly to mod. calcareous.

St. Norbert soils occur in close association with Scanterbury and Myrtle soils. They are similar to Myrtle soils by having a clay texture and being well drained but differ because of having developed under woodland invasion and exhibiting a leached, dark gray profile. St. Norbert soils were previously mapped as St. Norbert clay in the Winnipeg and Morris Map Sheet Areas.

A profile of a St. Norbert soil is included in Appendix F.

Seine River Series (SRR)

The Seine River series consists of imperfectly drained Gleyed Cumulic Regosol soils developed on moderately to strongly calcareous clayey alluvial deposits. They occur mainly on the intermediate position between the river bed and upper levees of the Assiniboine, La Salle, Rat, Red and Seine Rivers. They are subject to seasonal flooding during the spring runoff period; otherwise they have moderate runoff, and moderately slow to slow permeability. The native vegetation consists of Manitoba maple, elm, ash, basswood and native grasses.

The soil is characterized by a thin partially decomposed leaf mat 2 to 4 cm thick, and a variable dark gray Ah horizon of 3 to 6 cm thick; the Cgj horizon has a variable texture of silty clay to clay and may have thin former Ah horizons in the stratified layers below. In the upper slope positions these soils may have weak development of an Ah and Bm horizon grading to the Scanterbury or Myrtle series.

Willowbend Series (WWB)

The Willowbend series consists of poorly drained Rego Humic Gleysol soil developed on moderately to strongly calcareous, stratified, deep, loamy (L,SiL,CL,SiCL), recent alluvial deposits. Strata can vary in texture of FSL to CL depending on source area and position relative to stream channels. These soils occur in level to depressional positions of very gentle slopes on flood prone terraces and meander landscapes and have moderately slow permeability, very slow surface runoff, and a high to ponded water table during the growing season. Willowbend soils are noneroded, nonstony, and may be saline. They have a medium available water holding capacity, medium organic matter content, and low natural fertility. Native vegetation includes sedges, rushes, reeds and willows. The majority of these soils are currently in native vegetation.

In a representative profile of Willowbend soil the solum is not developed. The profile is characterized by a moderately decomposed LH horizon, 5 to 10 cm thick, a very dark gray Ah horizon, 15 to 20 cm thick with moderate calcareousness, and a light brownish gray to very pale brown Ck horizon with many prominent mottles. Buried Ah horizons often occur throughout the soil profile.

Willowbend soils occur in close association with La Salle and Gervais soils. Willowbend soils were previously mapped as an inclusion of the Riverdale Association in the Winnipeg Map Sheet (Report No. 5, 1953).

PART 4

USE AND MANAGEMENT INTERPRETATIONS OF SOILS

4.1 INTRODUCTION

This section provides predictions of performance or soil suitability ratings for various uses of soils based on field observations of soil and landscape characteristics, laboratory data and on observations of soil behavior under specified conditions of land use and management. Suitability ratings or interpretations are intended only to serve as guides for planners and managers. Caution, with an understanding of the limitations of the soil map must be exercised when applying suitability ratings to soil map units. The value of any rating or interpretation depends upon the nature and composition of individual map unit delineation which in turn depends on the scale of mapping and intensity of ground truthing employed in the survey.

In this section, interpretive soil information is provided for the following land use evaluations:

1. Agriculture
   a) dryland farming capability
   b) irrigation suitability
2. Engineering Uses
3. Recreation Uses

4.2 SOIL CAPABILITY FOR AGRICULTURE

Dryland Agriculture

Soil capability classification for dryland agriculture is based on an evaluation of both internal and external soil characteristics that influence soil suitability and limitations for agricultural use. In this classification, mineral soils are grouped into capability classes, subclasses and units based on their limitations for dryland farming, risk of damage when the soils are used and the way they respond to management[8]. There are seven capability classes, each of which groups soils together that have the same relative degree of limitation or hazard for agricultural use. The limitation becomes progressively greater from Class 1 to Class 7. The class indicates the general suitability of the soils for agriculture. The first three classes are considered capable of sustained production of common field crops, the fourth is marginal for sustained arable culture, the fifth is suitable only for improved permanent pasture, the sixth is capable of use only for native pasture while the seventh class is for soils and land types considered incapable of use for arable agriculture or permanent pasture.

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[8] Anon. 1965. Land capability classification for agriculture Report No. 2, Canada Land Inventory, Canada Dept. Regional Economic Expansion, Ottawa. 16 pp.

Organic soils within the map area are rated for "potential" agricultural capability after the method of Leeson[9]. Capability ratings of organic soils for agriculture must recognize that most organic soils have little or no value for agriculture in their native state and their potential is only achieved through reclamation or development implemented with varying degrees of difficulty. Capability class definitions for organic soils are the same as for mineral soils. They are however, identified on maps and tables with the prefix "O".

Soil Capability subclasses are divisions within classes which group soils with similar kinds of limitations and hazards for agricultural use. The various kinds of limitations recognized at the subclass level are defined in Table 4.

Soil capability units are divisions within the subclass category that groups soils together that will respond similarly to a given management input.

A summary of the soils in the study area showing their major characteristics and their interpretive classification for dryland agriculture is presented in Table 5.

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[9] Leeson, Bruce et al. 1969. An organic soil capability classification for agriculture and a study of the organic soils of Simcoe County, Soil Sci. Dept., Ontario Agricultural College, Guelph, Ontario.

Definitions of the Agricultural Capability Classes

Class 1

Soils in this class have no important limitations for crop use. The soils have level or gently sloping topography; they are deep, well to imperfectly drained and have moderate water holding capacity. The soils are naturally well supplied with plant nutrients, easily maintained in good tilth and fertility; soils are moderately high to high in productivity for a wide range of cereal and special crops.

Class 2

Soils in this class have moderate limitations that reduce the choice of crops or require moderate conservation practices. The soils have good water holding capacity and are either naturally well supplied with plant nutrients or are highly responsive to inputs of fertilizer. They are moderate to high in productivity for a fairly wide range of crops. The limitations are not severe and good soil management and cropping practices can be applied without serious difficulty.

Class 3

Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The limitations in Class 3 are more severe than those in Class 2 and conservation practices are more difficult to apply and maintain. The limitations affect the timing and ease of tillage, planting and harvesting, the choice of crops and maintenance of conservation practices. The limitations include one or more of the following: moderate climatic limitation, erosion, structure or permeability, low fertility, topography, overflow, wetness, low water holding capacity or slowness in release of water to plants, stoniness and depth of soil to consolidated bedrock. Under good management, these soils are fair to moderately high in productivity for a fairly wide range of field crops.

Class 4

Soils in this class have severe limitations that restrict the choice of crops or require special conservation practices or both. These soils have such limitations that they are only suited for a few crops, or the yield for a range of crops may be low, or the risk of crop failure is high. The limitations may seriously affect such farm practices as the timing and ease of tillage, planting and harvesting, and the application and maintenance of conservation practices. These soils are low to medium in productivity for a narrow range of crops but may have higher productivity for a specially adapted crop. The limitations include the adverse effects of one or more of the following: climate, accumulative undesirable soil characteristics, low fertility, deficiencies in the storage capacity or release of soil moisture to plants, structure or permeability, salinity, erosion, topography, overflow, wetness, stoniness, and depth of soil to consolidated bedrock.

Class 5

Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. These soils have such serious soil, climatic or other limitations that they are not capable of use for sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame species of perennial forage plants. Feasible improvement practices include clearing of bush, cultivation, seeding, fertilizing and water control.

Some soils in Class 5 can be used for cultivated field crops provided unusually intensive management is used. Some of these soils are also adapted to special crops requiring soil conditions unlike those needed by the common crops.

Class 6

Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible. Class 6 soils have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic or other limitations as to make impractical the application of improvement practices that can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents the use of farm machinery, or because the soils are not responsive to improvement practices, or because stock watering facilities are inadequate.

Class 7

Soils in this class have no capability for arable culture or permanent pasture because of extremely severe limitations. Bodies of water too small to delineate on the map are included in this class. These soils may or may not have a high capability for forestry, wildlife and recreation.

TABLE 4

Agricultural Capability Subclass Limitations

C - Adverse climate: This subclass denotes a significant adverse climate for crop production as compared to the "median" climate which is defined as one with sufficiently high growing season temperatures to bring field crops to maturity, and with sufficient precipitation to permit crops to be grown each year on the same land without a serious risk of partial or total crop failures.

D - Undesirable soil structure and/or low permeability: This subclass is used for soils difficult to till, or which absorb water very slowly or in which the depth of rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

E - Erosion: Subclass E includes soils where damage from erosion is a limitation to agricultural use. Damage is assessed on the loss of productivity and on the difficulties in farming land with gullies.

F - Low fertility: This subclass is made up of soils having low fertility that either is correctable with careful management in the use of fertilizers and soil amendments or is difficult to correct in a feasible way. The limitation may be due to lack of available plant nutrients, high acidity or alkalinity, low exchange capacity, high levels of carbonates or presence of toxic compounds.

I - Inundation by streams or lakes: This subclass includes soils subjected to inundation causing crop damage or restricting agricultural use.

L - Coarse wood fragments: In the rating of organic soils, woody inclusions in the form of trunks, stumps and branches (>10 cm diameter) in sufficient quantity to significantly hinder tillage, planting and harvesting operations.

M - Moisture limitation: This subclass consists of soils where crops are adversely affected by droughtiness owing to inherent soil characteristics. They are usually soils with low water-holding capacity.

N - Salinity: Designates soils which are adversely affected by the presence of soluble salts.

P - Stoniness: This subclass is made up of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations. Stony soils are usually less productive than comparable non-stony soils.

R - Consolidated bedrock: This subclass includes soils where the presence of bedrock near the surface restricts their agricultural use. Consolidated bedrock at depths greater than 1 meter from the surface is not considered as a limitation, except on irrigated lands where a greater depth of soil is desirable.

T - Topography: This subclass is made up of soils where topography is a limitation. Both the percent of slope and the pattern or frequency of slopes in different directions are important factors in increasing the cost of farming over that of smooth land, in decreasing the uniformity of growth and maturity of crops, and in increasing the hazard of water erosion.

W - Excess water: Subclass W is made up of soils where excess water other than that brought about by inundation is a limitation to their use for agriculture. Excess water may result from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.

X - Cumulative minor adverse characteristics: This subclass is made up of soils having a moderate limitation caused by the cumulative effect of two or more adverse characteristics which singly are not serious enough to affect the class rating.

Irrigation Suitability

Irrigation suitability of soils is determined by evaluating the nature of both internal and external soil characteristics[10]. The classification of soils for irrigation suitability consists of three categories: class, subclass and unit.

The suitability class groups soils having the same relative suitability or degree of limitation or hazard for irrigation use. Four classes are utilized grading from Class 1, which is very good to Class 4, which is poor. The four classes are:

Class 1 - Very good: These are soils of fine sandy loam to clay loam texture which are well suited for irrigation use. The soils have good water retention capacity, good permeability, low salt content, good drainage and low general gradient of land surface.

Class 2 - Good: These are soils of loamy fine sand to light clay texture which are moderately well suited for irrigation use. Slight limitation to use results from soil factors such as water holding capacity, permeability, depth of material, salt content, topographic factors such as slope and pattern or drainage restrictions arising from surface drainage and depth to water table.

Class 3 - Fair: These are coarse or fine textured soils which are fair to marginally suitable because of some unfavorable characteristics that limit production and cause management problems under irrigation use. Soil, topographic or drainage factors are more restrictive than in Class 2.

Class 4 - Poor: These are soils that are considered poor to unsuitable for irrigation use because of severe drainage problems, impermeable geologic material, salinity, very low water holding capacity, very rapid permeability, topography or a combination of these problems.

The suitability subclass identifies soils with similar kinds of limitations and hazards related to both internal and external soil characteristics. The internal characteristics include both permanent and non-permanent properties; the permanent properties are those that will not change over time whereas the non-permanent properties may be altered with time by specific management. The properties which affect irrigation suitability of soil are listed as follows:

1. Internal Characteristics

   a) Permanent - Texture, uniformity and depth of geologic deposit, hydraulic conductivity and water storage capacity

   b) Non-permanent - Structure, drainage, fertility, reaction, salinity, exchangeable sodium

2. External Characteristics

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[10] PFRA. 1964. Handbook for the classification of irrigation land in the prairie provinces. Prepared by Committee of the Canada Dept. of Agriculture. PFRA, Regina, Sask. 92 pp.

a) Topography, erosion, stoniness, vegetative cover

The classification criteria for irrigation suitability are summarized in Table 11, Appendix B. The soils of the Springstein, St. Eustache, Brunkild, SW Perimeter and La Salle R. areas are evaluated for irrigation suitability in Table 5.

TABLE 5. AGRICULTURE CAPABILITY CLASSES FOR SOILS

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability 11
BCK	Black Lake	2I	3S
BCK /xcxx	Black Lake	2T	3S
DCS	Dencross	2W	4SD
DFS	Dufresne	5WI	4D
DHO	Deadhorse	2W	4SD
DHO /xxxs	Deadhorse	3N	4SD
FTE	Fortier	2W	4DS
GOO	Glenmoor	3W	4D
GVS	Gervais	2W	3DS
HDG	Hodgson	2I	1
HDG /xcxx	Hodgson	2T	2T
MYT	Myrtle	1	4S
OBO	Osborne	3W	4D
OBO /xxxs	Osborne	3WN	4DS
PGK	Pigeon Lake	2W	3SD
PME	Plum Coulee	2W	4S
RIV	Red River	2W	4SD
SCY	Scanterbury	2W	4SD
SOR	St Norbert	2D	4S
SOR /xdxx	St Norbert	3T	4S
SOR /xfxx	St Norbert	5T	4T
SRE	Seine River	2I	4DS
SRE /xcxx	Seine River	2T	4SD
SRE /xdxx	Seine River	3T	4SD
WWB	Willowbend	5WI	4SD

4.3 SOIL SUITABILITY FOR SELECTED ENGINEERING USES

This section provides information which can be used by engineers and land use planners concerned with engineering and related geotechnical aspects of soil. It is intended to supplement the information on the soil map with additional data on engineering properties of soils.

The criteria used to evaluate soil suitability for selected engineering and related recreational uses are adopted from guides found in Coen et al[11]. and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture[12] and the Canada Soil Survey Committee[13].

Definition of Soil Suitability Classes

Evaluation of soil suitability for engineering and recreation uses is based on both internal and external soil characteristics. Four soil suitability classes are used to evaluate both mineral and organic soils and hence, mapping units for selected uses. These ratings express relative degrees of suitability or limitation for potential uses of natural or essentially undisturbed soils. The long term effects of the potential use on the behavior of the soil are considered in the rating.

The four suitability class ratings are defined as follows:

Good - Soils in their present state have few or minor limitations that would affect the proposed use. The limitations would easily be overcome with minimal cost.

Fair - Soils in their present state have one or more moderate limitations that would affect the proposed use. These moderate limitations would be overcome with special construction, design, planning or maintenance.

Poor - Soils in their present state have one or more severe limitations that would severely affect the proposed use. To overcome these severe limitations would require the removal of the limitation or difficult and costly alteration of the soil or of special design or intensive maintenance.

Very Poor - Soils have one or more features so unfavorable for the proposed use that the limitation is very difficult and expensive to overcome or the soil would require such extreme alteration that the proposed use is economically impractical.

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[11] Coen et al. 1977. Soil Survey of Yoho National Park, Canada. Alberta Soil Survey Report No. 37. 208 pp. Alberta Institute of Pedology, University of Alberta, Edmonton, Alberta.

[12] USDA. 1971. Guide for Interpreting Engineering Uses of Soils. Soil Conservation Service, USDA. SCS-45. 87 pp.

[13] CSSC. 1973. Proceedings of the Ninth Meeting of the Canada Soil Survey Committee, University of Saskatchewan, Saskatoon. 357 pp.

Soil Suitability Subclasses

The basic soil properties that singly or in combination with others commonly affect soil suitability for selected engineering properties and recreation uses are provided in Table 6. These subclass designations serve to identify the kind of limitation or hazard for a particular use.

Guides for Assessing Soil Suitability

Guides for assessing soil suitability for ten engineering related uses are given in Appendix B, Tables 12 to 21. These tables provide as specifically as possible, definitions of the soil properties which result in the specific suitability or degree of limitation. In assessing soil suitability for various engineering uses, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed soil properties. For example, if the suitability is "Good" for all but one soil property and it is estimated to be "Very Poor", then the overall rating of the soil for that selected use is "Very Poor". Suitability of individual soil properties, if estimated to be "Fair" or "Poor", can be accumulative in their effect for a particular use. Judgement is required to determine whether the severity of the combined effects of several soil properties on suitability for a particular use will result in downgrading an evaluation. This is left to the discretion of the interpreter. It is incorrect to assume that each of the major soil properties influencing a particular use has an equal effect. Class limits established for rating the suitability of individual soil properties take this into account. For a selected use, therefore, only those soil properties which most severely limit that use are specified.

Engineering description of the soils and their estimated properties significant to engineering are provided in Table 7. These data, in addition to information contained in other sections of the report have been used to rate the soils according to their suitability for ten selected engineering uses in Table 8. When using these interpretations, consideration must be given to the following assumptions:

1. Interpretations are based on predictions of soil behavior under defined conditions of use and management as specified in the preamble to each of Tables 12 through 25 (Appendix B).

2. Soil ratings do not include site factors such as nearness to towns and highways, water supply, aesthetic values, etc.

3. Soil ratings are based on natural, undisturbed soil.

4. Soil suitability ratings are usually given for the entire soil, but for some uses, they may be based on the limitations of an individual soil horizon or other earthy layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1 to 2 meters, but in some kinds of soils, reasonable estimates can be given for soil material at greater depths. It should be noted here that the term "soil" has been used throughout the report in the pedologic sense and differs in concept from that commonly used by engineers.

5. Poor and very poor soil ratings do not imply that a site cannot be changed to remove, correct or modify the soil limitations. The use of soils rated as poor depends on the nature of the limi-

tations, whether or not the soil limitation can be altered successfully and economically, and on the scarcity of good sites.

6. Interpretations of map units do not eliminate the need for on-site evaluation by qualified professionals. Due to the variable nature of soils, and the scale of mapping, small, unmappable inclusions of soils with different properties may be present in an area where a development is planned. The need for or importance of on-site studies depends on the use to be made of the soil and the kinds of soil and soil problems involved.

4.4 SOIL SUITABILITY FOR SELECTED RECREATION USES

This section provides interpretations of the soil suitability for recreational development. All types of soil can be used for recreational activities of some kind.

Soils and their properties determine to a large degree, the type and location of recreational facilities. Wet soils are not suitable for campsites, roads, playgrounds or picnic areas. Soils that pond and dry out slowly after heavy rains present problems where intensive use is contemplated. It is difficult to maintain grass cover for playing fields and golf courses on droughty soils. The feasibility of many kinds of outdoor activities are determined by other basic soil properties such as depth to bedrock, stoniness, topography or land pattern, and the ability of the soil to support vegetation of different kinds as related to its natural fertility.

The suitability of the various soil series and phases for selected recreation uses is shown in Table 9 according to four classes, Good, Fair, Poor and Very poor defined previously in the section on Engineering Uses. Subclasses are employed to identify the kind of limitation or hazard for a particular use. An explanation of subclass symbols are provided in Table 6.

The guidelines for various recreation uses are presented in Appendix B, Tables 22 to 25 and 15.

TABLE 6

Codes utilized to identify limitations in evaluating soil suitability for selected Engineering and Recreational Uses(Tables 8 and 9)

a	subgrade properties
b	thickness of topsoil
c	coarse fragments on surface
d	depth to bedrock
e	erosion or erodibility
f	susceptibility to frost hazard
g	contamination hazard of groundwater
h	depth to seasonal water table
i	flooding or inundation
j	thickness of slowly permeable material
k	permeability or hydraulic conductivity
l	shrink-swell properties
m	moisture limitations or deficit
n	salinity or sulphate hazard
o	organic matter
p	stoniness
q	depth to sand or gravel
r	rockiness
s	surface texture
t	topographic slope class
u	moist consistence
w	wetness or soil drainage class
z	permafrost

Table 7. Engineering Description of Soils and Their Estimated Properties Significant to Engineering Uses

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Disturbed* Hydraulic Conductivity (cm/hr)	Reaction (pH)	Electrical Conductivity (mS/cm)	Sulfate-Hazard**	Shrink-Swell Potential	Depth to Seasonal Water
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
BCR	Black Lake	0-40	C	CH	A-7-6	100	100	95-100	.01-.5	7.0-7.4	-	none	high	subject to flooding
		40-100	C	CH	A-7-6	100	100	85-100	.01-.5	7.5-7.8	<0.5	slight	high	
DCS	Dencross	0-40	C	CH	A-7-6	100	100	95-100	.5-2.0	6.5-7.2	-	none	high	seasonal 1.3 m
		40-85	SiL-SiCL	ML to CL	A-4,A-6	100	100	90-95	.5-6.0	7.6-8.0	<1.6	slight	mod.	
		85+	C	CH	A-7-6	100	100	95-100	<.5	7.6-8.0	<1.6	slight	high	
DFS	Dufresne	0-30	SiC-C	CH	A-7-6	100	100	95-100	.5-2.0	6.8-7.4	-	none	high	subject to flooding
		30+	C	CH	A-7-6	100	100	95-100	<.5	7.5-8.0	<1.6	low	high	
DHO	Deadhorse	0-30	C-SiC	OH	A-7-6	100	100	90-100	0.03-2.5	6.5-7.4	>2.0	low	high	0.8
		30-60	C-SiC	CH to MH	A-7-6	100	100	90-100	0.03-2.5	7.4-8.0	>2.0	low-mod.	high	
		60-120	C-SiC	CH to MH	A-7-6	100	100	90-100	0.03-2.5	8.0-8.2	>2.0	high	high	
FTR	Fortier	0-25	SiC-C	OH	A-7-6	100	100	95-100	0.1-0.25	7.4-8.2	>1.6	high	high	0.8
		25-85	SiC-C	MH	A-7-6	100	100	95-100	0.1-0.25	7.8-8.2	>1.6	high	high	
		85-110	FS-LVFS	SM to ML	A-2,A-4	100	100	15-70	5.0-12.0	7.8-8.2	>1.6	high	low	
GOO	Glenmoor	0-40	C	CH	A-7-6	100	100	95-100	.5-2.0	7.4-7.8	<0.5	low	high	seasonal near surface
		40-100	SiL-SiCL	ML to CL	A-4 to A-6	100	100	85-95	2.5	7.8-8.2	1.6	mod.	mod.	
		100+	C	CH	A-7-6	100	100	95-100	0.1	7.6-8.0	>1.6	mod.-high	high	
GVS	Gervais	0-25	SiL-SiCL	MH	A-7-6	100	100	90-100	0.5-5.0	6.8-7.4	<0.5	low	mod.	flood prone
		25-100	VFSL-SiCL	ML to CL	A-4,A-6	100	100	90-100	0.5-5.0	7.6-8.2	<1.6	low-mod.	mod.	
HDG	Hodgson	0-30	L-SiL	ML	A-4 to A-6	100	100	90-100	2-6	7.2-7.6	<1.0	low	mod.	subject to infreq. flooding
		30-60	VFS-SiL-SiCL	ML-CL	A-4 to A-6	100	100	90-100	2-6	7.4-7.8	<1.0	low	mod.	
		60-100	SiL-SiCL	ML-CL	A-4 to A-6	100	100	90-100	2-6	7.4-7.8	<1.0	low	mod.	
MYT	Myrtle	0-40	C	CH to OH	A-7-6	100	100	100	1.-2.5	6.5-7.0	<.5	low	high	>2 m
		40-100	C	CH	A-7-6	100	100	100	<2.0	7.4-7.8	<.5	low	high	
OSO	Osborne	0-35	C	OH	A-7-6	100	100	100	0.15	6.5-7.4	<1.6	mod.	high	surface ponding <1 m
		35-100	C	CH	A-7-6	100	100	100	0.15	7.8-8.2	<1.6	mod.	high	
PGR	Pigeon Lake	0-30	SiCL	ML to CL	A-4, A-7	100	100	75-100	0.5-5.0	6.8-7.4	<1.0	low	mod.	0.9 m
		30-90	Strat. VFSL-SiCL	ML to CL	A-4,A-6	100	100	75-100	0.5-5.0	7.8-8.2	<1.0	low	mod.	
		90-100	SiC-C	MH to CH	A-7-6	100	100	100	0.15	7.8-8.2	<1.0	low	high	
PMR	Plum Coulee	0-30	C-SiC	OH	A-7-6	100	100	100	0.1-1.5	6.5-7.4	<1.6	low-mod.	high	1.2
		30-60	C	CH	A-7-6	100	100	95-100	0.1-1.5	7.5-7.8	<1.6	low-mod.	high	
		60-120	SiCL-C	MH to CH	A-7-6	100	100	90-100	0.25-1.5	7.8-8.0	>1.6	mod.-high	high	
RIV	Red River	0-30	C	OH	A-7-6	100	100	100	0.1	6.5-7.4	<1.6	low-mod.	high	1.5 m
		30-100	C	CH	A-7-6	100	100	100	0.1	7.6-8.2	<1.6	low-mod.	high	
SCY	Scanterbury	0-25	C	OH	A-7-6	100	100	90-100	<0.5	6.6-7.0	-	low	high	1.5 m
		25-60	C	CH	A-7-6	100	100	90-100	<0.5	7.0-7.6	<0.3	low	high	
		60+	C	CH	A-7-6	100	100	90-100	<0.1	7.8-8.2	<1.6	low-mod.	high	
SOR	St. Norbert	0-40	C	CH-OH	A-7-6	100	100	100	1-2.5	6.0-7.0	<0.5	low	high	>2 m
		40-65	SiC-C	CH	A-7-6	100	100	100	.5-2	7.6-8.2	<0.5	low	high	
		65+	C	CH	A-7-6	100	100	100	<.5	7.6-8.2	<0.5	low	high	
SRE	Seine River	0-25	SiC	OH	A-7-6	100	100	95-100	.5-2.0	6.5-7.0	<.5	low	high	occe-sional flooding
		25-60	SiC-C	CH	A-7-6	100	100	95-100	<.5	7.2-7.4	<.5	low	high	
		60+	C	CH	A-7-6	100	100	95-100	<.1	7.4-7.8	<1.6	mod.	high	

Table 7. Engineering Description of Soils and Their Estimated Properties Significant to Engineering Uses

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Disturbed* Hydraulic Conductivity (cm/hr)	Reaction (pH)	Electrical Conductivity (mS/cm)	Sulfate-Hazard**	Shrink-Swell Potential	Depth to Seasonal Water
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
WnB	Willow-bend	0-35	L-CL	OL,OH	A-6,A-7	100	100	65-100	-	6.5-7.4	<1.6	low	low	flood
		35-100	strat. FS-SiCL	ML,CL	A-4,A-6	100	100	30-100	variable	7.8-8.2	<1.6	low-mod.	low-mod.	prone

* Permeability of horizons or layers is expressed in cm/hr

** Sulfate Hazard - relative degree of sulfate attack on concrete based on criteria established by U.S. Bureau of Reclamation.

very rapid	>25 cm/hr	moderate	2.5-5.0 cm/hr
rapid	15-25 cm/hr	moderately slow	1.5-2.5 cm/hr
moderately rapid	5-15 cm/hr	slow	.125-1.5 cm/hr
		very slow	<.125

Abbreviations:
mod. - moderate
neg. - negligible

TABLE 8. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil 12	Sand & Gravel 13	Road Fill 14	Permanent Bldgs. With Basements 15	Local Roads and Streets 16	Sanitary Trench 17	Landfill Area 18	Cover Material 19	Sewage Lagoons 20	Septic Fields 21
BCK	Black Lake	Ps	Va	Pa	Pia	Pa	Pis	Fi	Ps	Pi	Pik
BCK /xcxx	Black Lake	Ps	Va	Pa	Pia	Pa	Pis	Fi	Ps	Pi	Pik
DCS	Dencross	Ps	Va	Paf	Pwa	Pa	Psw	Fw	Ps	Faj	Phk
DFS	Dufresne	Viw	Va	Pw	Vi	Vi	Viw	Vi	Vw	Vi	Vi
DHO	Deadhorse	Ps	Va	Pa	Pwa	Pa	Pws	Fw	Ps	Fah	Pkh
DHO /xxxs	Deadhorse	Psn	Va	Pa	Pwa	Pa	Pws	Fw	Ps	Fah	Pkh
FTE	Fortier	Ps	Va	Pa	Paw	Pa	Pws	Pi	Ps	Vi	Phi
GOO	Glenmoor	Psw	Va	Paf	Pw	Paw	Vw	Pw	Psw	Faj	Vh
GVS	Gervais	Fis	Va	Faw	Piw	Pi	Piw	Pi	Fs	Vi	Phi
HDG	Hodgson	Fs	Va	Fa	Fa	Fia	Fs	Fi	Fs	Pi	Fk
HDG /xcxx	Hodgson	Fs	Va	Fa	Fa	Fia	Fs	Fi	Fs	Pi	Fk
MYT	Myrtle	Ps	Va	Pal	Pa	Pa	Ps	G	Ps	G	Pk
OBO	Osborne	Ps	Va	Paw	Paw	Paw	Vw	Pw	Psw	G	Vkh
OBO /xxxs	Osborne	Psn	Va	Pwa	Pwa	Paw	Vw	Pw	Psw	G	Vh
PGK	Pigeon Lake	Fs	Va	Faw	Piw	Pi	Piw	Pi	Fs	Vi	Phi
PME	Plum Coulee	Ps	Va	Pa	Pwa	Pa	Pws	Fw	Ps	Fah	Pkh
RIV	Red River	Ps	Va	Pa	Paw	Pa	Pws	Fw	Ps	G	Vk
SCY	Scanterbury	Ps	Va	Pa	Paw	Pa	Pws	Fw	Ps	G	Vk
SOR	St Norbert	Ps	Va	Pal	Pa	Pa	Ps	G	Ps	G	Pk
SOR /xdxx	St Norbert	Ps	Va	Pa	Pa	Pa	Ps	G	Ps	Pt	Pk
SOR /xfxx	St Norbert	Vt	Va	Pa	Pat	Pat	Ps	Pt	Pst	Vt	Pkt
SRE	Seine River	Psi	Va	Pa	Pwa	Pa	Pwi	Pi	Ps	Vi	Phi
SRE /xcxx	Seine River	Pis	Va	Pa	Pwa	Pa	Piw	Pi	Ps	Vi	Pi
SRE /xdxx	Seine River	Pis	Va	Pa	Pwa	Pa	Piw	Pi	Ps	Vi	Pi
WWB	Willowbend	Vw	Va	Pw	Vi	Vi	Viw	Vi	Vw	Vi	Vi

TABLE 9. SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground 22	Picnic Area 23	Camp Area 24	Path And Trails 25	Permanent Bldgs. Without Basements 15
BCK	Black Lake	Fs	Fs	Fs	Fs	Pia
BCK /xcxx	Black Lake	Fst	Fs	Fs	Fs	Pia
DCS	Dencross	Ps	Ps	Ps	Ps	Pa
DFS	Dufresne	Vi	Vi	Vi	Vi	Vi
DHO	Deadhorse	Ps	Ps	Ps	Ps	Pa
DHO /xxxs	Deadhorse	Ps	Psn	Psn	Ps	Pa
FTE	Fortier	Ps	Ps	Ps	Ps	Pa
GOO	Glenmoor	Psw	Psw	Psw	Psw	Paw
GVS	Gervais	Fsw	Fsw	Fsw	Fsw	Pi
HDG	Hodgson	Fs	Fs	Fs	Fs	Fa
HDG /xcxx	Hodgson	Fs	Fs	Fs	Fs	Fa
MYT	Myrtle	Fs	Fs	Fs	Fs	Pa
OBO	Osborne	Psw	Psw	Psw	Psw	Paw
OBO /xxxs	Osborne	Pws	Pws	Pws	Pws	Pwa
PGK	Pigeon Lake	Fsw	Fsw	Fsw	Fsw	Pi
PME	Plum Coulee	Ps	Ps	Ps	Ps	Pa
RIV	Red River	Ps	Ps	Ps	Ps	Pa
SCY	Scanterbury	Ps	Ps	Ps	Ps	Pa
SOR	St. Norbert	Fs	Fs	Fs	Fs	Pa
SOR /xdxx	St Norbert	Pt	Fs	Fs	Fs	Pa
SOR /xfxx	St Norbert	Vt	Pt	Pt	Fst	Pat
SRE	Seine River	Ps	Ps	Pis	Ps	Pa
SRE /xcxx	Seine River	Ps	Ps	Pis	Ps	Pa
SRE /xdxx	Seine River	Pts	Ps	Pis	Ps	Pa
WWB	Willowbend	Viw	Viw	Viw	Viw	Viw

Appendix A

CORRELATION OF THE SOILS IN THE SPRINGSTEIN, ST. EUSTACHE, BRUNKILD, SOUTHWEST PERIMETER AND LA SALLE R. AREAS WITH THE SOILS IN THE WINNIPEG MAP SHEET AREA, REPORT NO. 5, 1953

The detailed resurvey study covers 6 300 hectares in the southwest portion of the Winnipeg Map Sheet and includes the five selected areas. The resurvey benefits from advantages derived from more frequent and intensive examination of soils in the field, use of a larger mapping scale in order to permit delineation of numerous important local soils, use of modern aerial photographs and use of improved methods of studying soils in the laboratory. In particular, changes in the stratigraphy of surface deposits, depth and type of soil profile, degree of erosion, slope, stoniness and salinity are emphasized.

In a reconnaissance soil survey, the area involved and the scale of the map used is such that it is impossible to show each individual soil as a unit. On the reconnaissance map of the Morris and Winnipeg Map Sheets, each unit shown, in most cases, may be considered a compound unit consisting of a complex of soil types known as a "soil association", having a dominant soil type interspersed with related but unlike local soil types in lesser proportion. However, while soil associations are the primary units generally shown on the reconnaissance map, local associated soils, phases and textural classes are occasionally mapped or designated as separate units where the areas involved are substantial or where such units are of sufficient local importance. In some instances such units are identified on the reconnaissance map by site symbols or hatching.

The associated genetic soil types that are developed on similar regional materials or geological deposits in the same zone are designated as a "soil association" and the individual associated soils, which are recognized by their soil profile characteristics, are referred to as "soil associates". These soil associates can be classed as genetic soil types that have developed under different drainage or moisture conditions, namely, variation in local soil climate.

In the present detailed maps of the study areas, each unit shown is either a simple unit consisting of a single soil type referred to as a "soil series" or a specifically defined compound unit containing one dominant soil series and usually one other related but unlike soil series associated with it. Soil series in terms of current Canadian Soil Classification criteria (CSSC 1978) are approximately equivalent to soil associates as defined in the 1953 study. In general, the range in allowable variation in profile characteristics and properties of soil series is significantly less than the range permitted in so-called soil associates.

The detailed resurvey of the study provides for improved quality and reliability of the soil map for a variety of interpretive applications

including, recreation, engineering and agriculture. Correlation of the soil series in the resurvey area with soil associations and soil associates of the Winnipeg Map Sheet Area is provided in Table 10.

Table 10. Correlation of Soil Series in the Study Area with Soil Associations and Associates of the Winnipeg Map Sheet Area, Report No. 5, 1953

Soil Symbol	Soil Series Name	Subgroup	Corresponding Soil Association or Associate of the Winnipeg Map Sheet	Remarks
BCK	Black Lake	Cumulic Regosol	Riverdale	The same as the well drained, clay to silty clay textured associate of the Riverdale Association.
DCS	Dencross	Gleyed Rego Black	Fort Garry	A significant inclusion in and the same as the intermediately drained blackearth-meadow associate of the Fort Garry Association.
DFS	Dufresne	Rego Humic Gleysol	Riverdale	The poorly drained, meadow soil of the Riverdale Association.
DHO	Deadhorse	Gleyed Rego Black	Oakville	Similar to the intermediately drained, blackearth-meadow associate of the Oakville silty clay to clay where profile development has taken place.
FTE	Fortier	Gleyed Cumulic Regosol	Oakville, Riverdale	The immature, clay to silty clay, intermediately drained associate of the Oakville Association. Similar to the intermediately drained, recent, silty clay deposit in the Riverdale Association.
GOO	Glenmoor	Rego Humic Gleysol	Fort Garry	The same as the poorly drained, meadow associate of the Fort Garry Association.
GVS	Gervais	Gleyed Cumulic Regosol	Riverdale	A significant inclusion in and the same as the imperfectly drained, loam to silty clay loam textured associate of the Riverdale Association.
HDG	Hodgson	Cumulic Regosol	Riverdale	A significant inclusion in and the same as the well drained (phytomorphic) member of the Riverdale Association.
MYT	Myrtle	Orthic Black	Red River	The same as the well drained, Blackearth associate of the Red River Association.
OBO	Osborne	Rego Humic Gleysol	Osborne	Equivalent to the Osborne clay associate of the Red River Association.
PGK	Pigeon Lake	Gleyed Cumulic Regosol	Oakville	An inclusion in the Oakville Association whereby the intermediately drained loam to silty clay loam sediments are underlain by lacustrine clay deposits.

Table 10. Continued

Soil Symbol	Soil Series Name	Subgroup	Corresponding Soil Association or Associate of the Winnipeg Map Sheet	Remarks
PME	Plum Coulee	Gleyed Black	Oakville	A significant inclusion in and the same as the blackearth-meadow associate of the Oakville Association. A considerable amount of profile development has taken place away from the stream channels.
RIV	Red River	Gleyed Rego Black	Red River	The same as the dominant soil in the Red River Association. The intermediately drained, blackearth-meadow, Red River clay associate.
SCY	Scanterbury	Gleyed Black	Red River	A significant inclusion in and the same as the intermediately drained, blackearth-meadow associate of the Red River Association with greater profile development.
SOR	St. Norbert	Orthic Dark Gray	St. Norbert	Equivalent to the St. Norbert clay which is the well drained (phytomorphic) wooded associate of the Red River Association. These soils have developed on the better drained sites, particularly adjacent to the river channels, where an invasion of oak and poplar has formed. Under these conditions the soils show varying degrees of degradation or modification by leaching resulting in degrading Blackeath or Grey-Black soils.
SRE	Seine River	Gleyed Cumulic Regosol	Riverdale	The same as the imperfectly drained, recent alluvial deposit of the feebly developed Riverdale Association having a silty clay texture.
WWB	Willowbend	Rego Humic Gleysol	Riverdale	A minor inclusion in and the same as the poorly drained, meadow associate of the Riverdale Association.

Appendix B

GUIDES FOR EVALUATING SOIL SUITABILITY FOR SELECTED USES

TABLE 11

Land Classification Standards for Irrigation Suitability

Land Characteristics	Subclass	Class 1 - Very Good	Class 2 - Good	Class 3 - Fair	Class 4 - Poor
SOILS	S				
Texture					
very coarse textured very fine textured	v h	Fine sandy loams to clay loams	Loamy fine sand to light clay	Sand to permeable clay	Gravel to clay
Water holding capacity low available moisture capacity	q	40 to 60 sat. % >15cm storage in 1.2m <10cm/hr. hydraulic cond.	35 to 65 sat. % >12.5cm storage in 1.2m <12.5cm/hr. hydraulic cond.	25 to 75 sat. % >7.5cm storage in 1.2m <17.5cm/hr. hydraulic cond.	<25 or >75 sat. % <7.5cm storage in 1.2m >17.5cm/hr. hydraulic cond.
Geological Deposit shallow deposit over sand or gravel	k	.9m or more of fine sandy loam or heavier	.6m or more of fine sandy loam or heavier, or .75m plus of loamy fine sand or sandy loam	.5m or more of sandy loam or heavier, or .6m plus of loamy sand	<.5m of sandy loam or heavier, or .6m of loamy sand or sand
shallow deposit over impervious substrata	b	>3m of permeable material	>2m of permeable material	>1m of permeable material	<1m of permeable material
Salinity and Alkalinity[1,2]	a	<4 ms/cm in 0-.6m <8 ms/cm below .6m <6 S.A.R.	<4 ms/cm in 0-.6m <12 ms/cm below .6m <8 S.A.R.	<8 ms/cm in 0-.6m <15 ms/cm below .6m <12 S.A.R.	>8 ms/cm in 0-.6m >15 ms/cm below .6m >12 S.A.R.
EXTERNAL FEATURES					
Stones - rock clearing	r	None to light clearing	Light to medium clearing	Light to heavy clearing	Excessively stony
Topography	T				
Slope excess gradient	g	<1% and 0.1% in general gradient (0-3% slope)	<3% in general gradient (3-5% slope)	<5% in general gradient (5-10% slope)	>5% in general* gradient (>10% slope)**
DRAINAGE	D				
restricted outlet		No problem anticipated	Moderate drainage problem anticipated but may be improved at relatively low cost	Moderate to severe drainage problem anticipated but may be improved by expensive but feasible measures	Drainage improvement not considered feasible
water table		below 2.4m most of year	could be above 1.5m for a short period, then recedes to 2.4m or lower	within 1.5m most of year	within 1m most of year

* Criteria for gravity (flood) irrigation requirements.

** Estimated adjustments to slope criteria for overhead or sprinkler type irrigation methods.

1 If sufficient gypsum is present in the soil, the S.A.R. may be lowered by leaching the soil (a very slow process), and the hydraulic conductivity may then improve.

2 The degree of salinity may vary widely within short distances, and there may be no clear indication of the area occupied by each salinity class. Unless a very detailed mapping and sampling program is carried out, it is impossible to estimate the acreage occupied by each salinity class.

TABLE 12

Guide for assessing soil suitability as source of topsoil

The term "topsoil" includes soil materials used to cover barren surfaces exposed during construction, and materials used to improve soil conditions on lawns, gardens, flower beds, etc. The factors to be considered include not only the characteristics of the soil itself, but also the ease or difficulty of excavation, and where removal of topsoil is involved, accessibility to the site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
i	Flooding	None	May flood occasionally for short periods	Frequent flooding	Constantly flooded
w	Wetness[2]	Wetness is not determining if better than very poorly drained.			Very poorly drained and permanently wet soils
t	Slope	0-5%	5-9%	9-15%	>15%
p	Stoniness[2]	Stones 10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones 0.1 m apart (Class 5)
c	Coarse fragments[2]: percent, by volume	<3%	3-15%	15-35%	>35%
s	Texture[2]	FSL, VFSL, L, SiL, SL, SC if 1:1 clay is dominant	CL, SCL, SiCL, SC if 2:1 clay is dominant; c and sic if 1:1 clay is dominant	S, LS, C and SiC if 2:1 clay is dominant. organic soils[3]	Marl, diatomaceous earth
b	Depth of Topsoil[4]	>40 cm	15-40 cm	8-15 cm	<8 cm
n	Salinity of Topsoil[5]	E.C. 0-1	E.C. 1-4	E.C. 4-8	E.C. >8

1/ The symbols are used to indicate the nature of the limitation.

2/ For an explanation of texture, consistence, stoniness, coarse fragments and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

3/ Non-woody organic materials are assessed as good sources for topsoil if mixed with or incorporated into mineral soil.

4/ The remaining soil material (at least 8 cm) must be reclaimable after the uppermost soil is removed.

5/ E.C. = Electrical Conductivity (millisiemens/cm).

TABLE 13

Guide for assessing soil suitability as source of sand and gravel

The purpose of this table is to provide guidance for assessing the probable supply as well as quality of the sand or gravel for use as road base material and in concrete. The interpretation pertains mainly to the characteristics of the soil substratum to a depth of 150 cm, augmented by observations made in deep cuts as well as geological knowledge where available.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Unified Soil Group	SW SP GW GP	SW-SM SP-SM GP-GM GW-GM	SM SW-SC SP-SC GM GP-GC GW-GC	All other groups and bedrock
h	Depth to Seasonal Water Table	Not class determining if deeper than 50 cm		50 cm	
q	Depth to Sand and Gravel	<25 cm	25-75 cm[2]	>75 cm[2]	
p	Stoniness[3]	Not class determining if stones >.5 m apart (Class 0, 1, 2 and 3)		Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
d	Depth to Bedrock	>100 cm	50-100 cm	<50 cm	

[1] The symbols are used to indicate the nature of the limitation.

[2] Rated good if it is known that the underlying gravel or sand deposit is thick (>100 cm).

[3] For an explanation of stoniness and rockiness, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

TABLE 14

Guide for assessing soil suitability as source of roadfill

Fill material for buildings or roads are included in this use. The performance of the material when removed from its original location and placed under load at the building site or road bed are to be considered. Since surface materials are generally removed during road or building construction their properties are disregarded. Aside from this layer, the whole soil to a depth of 150-200 cm should be evaluated. Soil materials which are suitable for fill can be considered equally suited for road subgrade construction.

Symbol[1]	Items Affecting Use[2]	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	Subgrade[3]				
	a. AASHO group index[4]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[5] and SC[5]	CL (with P.I.[6] <15) and ML	CL (with P.I.[6] of 15 or more), CH and MH[7]	OL, OH and Pt
l	Shrink-swell potential	Low	Moderate	High	
f	Susceptibility to frost action[8]	Low	Moderate	High	
t	Slope	0-15%	15-30%	30-45%	>45%
p	Stoniness[9]	Stones >2 m apart (Class 0, 1 and 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[9]	Rock exposures >35 m apart and cover <10% of the surface	Rock exposure 10-35 m apart and cover 10-25% of the surface	Rock exposure 3.5-10 m apart and cover 25-50% of the surface	Rock exposures <3.5 m apart and cover 50-90% of the surface
w	Wetness[9]	Excessively drained to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
d	Depth to Bedrock	>100 cm	50-100 cm	20-50 cm	<20 cm
h	Depth to Seasonal Water Table	>150 cm	75-150 cm	50-75 cm	<50 cm

1/ The symbols are used to indicate the nature of the limitation.

2/ The first three items pertain to soil after it is placed in a fill; the last six items pertain to soil in its natural condition before excavation for road fill.

3/ This item estimates the strength of the soil material, that is, its ability to withstand applied loads.

4/ Use AASHO group index only where laboratory data are available for the kind of soil being rated; otherwise, use Unified soil groups.

5/ Downgrade suitability rating to fair if content of fines is more than about 30 percent.

6/ P.I. means plasticity index.

7/ Upgrade suitability rating to fair if MH is largely kaolinitic, friable, and free of mica.

8/ Use this item only where frost penetrates below the paved or hardened surface layer and where moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front.

9/ For an explanation of stoniness, rockiness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

TABLE 15

Guide for assessing soil suitability for permanent buildings

This guide applies to undisturbed soils to be evaluated for single-family dwellings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundation requirements; but soil slope, susceptibility to flooding and other hydrologic conditions, such as wetness, that have effects beyond those related exclusively to foundations are considered too. Also considered are soil properties, particularly depth to bedrock, which influence excavation and construction costs for the building itself and for the installation of utility lines. Excluded are limitations for soil corrosivity, landscaping and septic tank absorption fields.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability[3]			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[4]	With Basements: Very rapidly, rapidly and well drained. Without Basements: Very rapidly, rapidly, well and moderately well drained.	With Basements: Moderately well drained. Without Basements: Imperfectly drained.	With Basements: Imperfectly, poorly, and very poorly drained. Without Basements: Poorly and very poorly drained.	With Basements: Permanently wet soils. Without Basements: Permanently wet soils.
h	Depth to Seasonal Water Table	With Basements: >150 cm Without Basements: >75 cm	With Basements: 75-150 cm Without Basements: 50-75 cm	With Basements: 25-75 cm Without Basements: 25-50 cm	With Basements: <25 cm Without Basements: <25 cm
i	Flooding	None	None	Occasional flooding (once in 5 years)	Frequent flooding (every year)
t	Slope[5]	0-9%	9-15%	15-30%	>30%
s	Subgrade[6]				
	a. AASHO group index[7]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM and OC and SC	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Potential Frost Action[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[4]	Stones >10 m apart (Class 0 to 1)	Stones 2-10 m apart (Class ≥10[10])	Stones 0.1-2 m apart (Class ≥10[10] to 4)	Stones <0.1 m apart (Class ≤10[10])
r	Rockiness[4],[11]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to allow location of permanent buildings
d	Depth to Bedrock[11]	With Basements: >150 cm Without Basements: >100 cm	With Basements: 100-150 cm Without Basements: 50-100 cm	With Basements: 50-100 cm Without Basements: <50 cm	With Basements: <50 cm

1/ By halving the slope limits, this table can be used for evaluating soil suitability for buildings with large floor areas, but with foundation requirements not exceeding those of ordinary three-storey dwellings.

2/ The symbols are used to indicate the nature of the limitation.

3/ Some soils assessed as fair or poor may be good sites from an aesthetic or use standpoint, but they will require more site preparation and/or maintenance.

4/ For an explanation of rockiness, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Reduce the slope limits by one half for those soils subject to hillside slippage.

6/ This item estimates the strength of the soil, that is, its ability to withstand applied loads. When available, AASHO Group Index values from laboratory tests were used; otherwise the estimated Unified classes were used.

7/ Group index values were estimated from information published by the Portland Cement Association (PCA, 1962), pp. 23-25.

8/ P.I. means plasticity index.

9/ Frost heave only applies where frost penetrates to the assumed depth of the footings and the soil is moist. The potential frost action classes are taken from the United States Army Corps of Engineers (1962), pp. 5-8.

10/ Rate one class better for buildings without basements.

11/ Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment such as backhoes.

TABLE 16

Guide for assessing soil suitability for local roads and streets

This guide applies to soils to be evaluated for construction and maintenance of local roads and streets. These are improved roads and streets having some kind of all-weather surfacing, commonly asphalt or concrete, and are expected to carry automobile traffic all year. They consist of: (1) the underlying local soil material (either cut or fill) called the subgrade; (2) the base material of gravel, crushed rock, or lime or soil cement stabilized soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They also are graded to shed water and have ordinary provisions for drainage. With the probable exception of the hardened surface layer, the roads and streets are built mainly from the soil at hand, and cuts and fills are limited, usually less than 2 meters. Excluded from consideration in this guide are highways designed for fast-moving, heavy trucks.

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth of hardrock, stoniness, rockiness, and wetness affect the ease of excavation and the amount of cut and fill to reach an even grade.

Symbol[2/]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[3/]	Very rapidly, rapidly, well and moderately well drained	Imperfectly drained	Poorly and very poorly drained	Permanently wet soils
i	Flooding	None	Infrequent (once in 5 years)	Occasional (once in 2-4 years)	Frequent (every year)
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Bedrock[4/]	>100 cm	50-100 cm	<50 cm	
s	Subgrade[5/]				
	a. AASHO group index[6/]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[7/] and SC[7/]	CL (with P.I.[8/] <15) and ML	CL (with P.I.[8/] of 15 or more), CH and MH	OH, OL and Pt
f	Susceptibility to Frost Heave[9/]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[3/]	Stones >2 m apart (Class 0 to 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[3/]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to permit location of roads and streets

1/ These guidelines, with some adjustment of slope and rockiness limits, will also be useful for assessing soils for use as parking lots.

2/ Symbols are used to indicate the nature of the limitation.

3/ For an explanation of stoniness, rockiness and soil drainage classes, see the Canada Soil Information System (Canada Soil Survey Committee, 1978).

4/ Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery.

5/ This item estimates the strength of soil materials as it applies to roadbeds. When available, AASHO Group Index values from laboratory tests were used; otherwise, the estimated Unified classes were used. The limitations were estimated assuming that the roads would be surfaced. On unsurfaced roads, rapidly drained, very sandy, poorly graded soils may cause washboard or rough roads.

6/ Group index values were estimated from information published by the Portland Cement Association (PCA, 1962) pp. 23-25.

7/ Downgrade to moderate if content of fines (less than 200 mesh) is greater than about 30 percent.

8/ P.I. means plasticity index.

9/ Frost heave is important where frost penetrates below the paved or hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing point. The susceptibility classes are taken from the United States Army Corps of Engineers (1962) pp. 5-8.

TABLE 17

Guide for assessing soil suitability for trench type sanitary landfills

The trench-type sanitary landfill is a sanitary landfill, in which dry garbage and trash is buried daily in an open trench and covered with a layer of soil material. Suitability of the site is dependent upon the potential for pollution of water sources through groundwater contact with the refuse, or leachate arising from the site. Those properties affecting ease of excavation of the site must be supplemented with geological and hydrological knowledge to provide subsurface soil and groundwater data to a depth of at least 3 to 4.5 m, a common depth of landfills.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G[3]	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal High Water Table	Not class determining if more than 180 cm		100-180 cm	<100 cm
w	Wetness[4]	Not class determining if better than imperfectly drained		Imperfectly drained	Poorly and very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[5]	<5 cm/hr	<5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-15%	15-30%	30-45%	>45%
e	Soil Texture[4],[6] (dominant to a depth of 150 cm)	SL, L, SiL, SCL	SiCL[7], CL, SC, LS	SiC, C	Muck, peat, gravel, sand
d	Depth to Hard Bedrock Rippable	>150 cm >150 cm	>150 cm 100-150 cm	100-150 cm 100-150 cm	<100 cm <100 cm
p	Stoniness[4]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
r	Nature of Bedrock	Impermeable			Highly permeable, fractured, easily soluble

1/ Based on soil depth (120 cm) commonly investigated in making soil surveys.

2/ The symbols are used to indicate the nature of the limitation.

3/ If probability is high that the soil material to a depth of 3 to 4.5 m will not alter a rating of good or fair, indicate this by an appropriate footnote, such as "Probably good to a depth of 3.5 m", or "Probably fair to a depth of 3.5 m".

4/ For an explanation of stoniness, texture and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Reflects ability of soil to retard movement of leachate from the landfills; may not reflect a limitation in arid and semiarid areas.

6/ Reflects ease of digging and moving (workability) and trafficability in the immediate area of the trench where there may not be surfaced roads.

7/ Soils high in expansive clays may need to be given a suitability rating of poor.

TABLE 18

Guide for assessing soil suitability for area-type sanitary landfills

In the area-type sanitary landfill refuse is placed on the surface of the soil in successive layers. The daily and final cover material generally must be imported. A final cover of soil material at least 60 cm thick is placed over the fill when it is completed.

The soil under the proposed site should be investigated so as to determine the probability that leachates from the landfill can penetrate the soil and thereby pollute water supplies.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal Water Table[2]	>150 cm	150-100 cm	50-100 cm	<50 cm
w	Wetness[2],[3]	Rapid to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[4],[5]	Not class determining if less than 5 cm/hr		5-15 cm/hr	>15 cm/hr
t	Slope	0-9%	9-15%	15-30%	>30%

[1] The symbols are used to indicate the nature of the limitation.

[2] Reflects influence of wetness on operation of equipment.

[3] For an explanation of drainage, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[4] Reflects ability of the soil to retard movement of leachate from landfills; may not reflect a limitation in arid and semiarid areas.

[5] Due to possible groundwater contamination, impermeable bedrock is considered poor and permeable bedrock is rated very poor for area-type sanitary landfills.

TABLE 19

Guide for assessing soil suitability as cover material for area-type sanitary landfills

The term cover material includes soil materials used to put a daily and final covering layer on refuse in area-type sanitary landfills. This cover material may be derived from the area of the landfill or may be brought in from surrounding areas.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
s	Texture[2],[3]	SL, L, SiL, SCL	SiCL, CL, SC, LS	SiC, C	Muck, peat, sand, gravel
d	Depth to bedrock[4]	>150 cm	100-150 cm	50-100 cm	<50 cm
c	Coarse fragments[2]	<15%	15-35%	>35%	
p	Stoniness[2]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
t	Slope	<9%	9-15%	15-30%	>30%
w	Wetness[2]	Not class determining if better than poorly drained		Poorly drained	Very poorly drained or permanently wet soils

1/ The symbols are used to indicate the nature of the limitation.

2/ For an explanation of consistence, texture, coarse fragments, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

3/ Soils having a high proportion of non-expansive clays may be given a suitability rating one class better than is shown for them in this table.

4/ Thickness of material excluding topsoil, which will be stockpiled (see guide for topsoil).

TABLE 20

Guide for assessing soil suitability for reservoirs and sewage lagoons

Factors affecting the ability of undisturbed soils to impound water or sewage and prevent seepage are considered for evaluating soils on their suitability for reservoir and lagoon areas. This evaluation considers soil both as a vessel for the impounded area and as material for the enclosing embankment. As the impounded liquids could be potential sources of contamination of nearby water supplies, e.g. sewage lagoons, the landscape position of the reservoir as it affects risk of flooding must also be considered.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Water Table[2]	>150 cm	100-150 cm	50-100 cm	<50 cm
i	Flooding[3]	None	None	Subject to infrequent flooding (once in 50 years)	Subject to frequent high level flooding
k	Soil Permeability	0-0.5 cm/hr	0.5-5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-2%	2-5%	5-9%	>9%
o	Organic Matter	<2%	2-10%	10-30%	>30%
c	Coarse Fragments[4] <25 cm in diameter, % by volume	<20%	20-35%	>35%	
p	Stoniness[4], >25 cm diameter, percent of surface area	<3% (Class 0, 1 and 2)	3-15% (Class 3)	15-50% (Class 4)	>50% (Class 5)
d	Depth to Bedrock[5]	>150 cm	100-150 cm	50-100 cm	<50 cm
j	Thickness of Slowly Permeable Layer	>100 cm	50-100 cm	50-25 cm	<25 cm
a	Subgrade Unified Soil Classes	GC, SC, CL, & CH	GM, ML, SM & MH	SW & SP	OL, OH & Pt GP, GW

1/ The symbols are used to indicate the nature of the limitation.

2/ If the floor of the lagoon has nearly impermeable material at least 50 cm thick, disregard depth to water table.

3/ Disregard flooding if it is not likely to enter or damage the lagoon (flood waters have low velocity and depth less than 150 cm).

4/ For an explanation of coarse fragments and stoniness classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Surface exposures of non rippable rock are rated very poor. If underlying bedrock is impermeable, rating should be one class better.

TABLE 21

Guide for assessing soil suitability for septic tank absorption fields

This guide applies to soils to be used as an absorption and filtering medium for effluent from septic tank systems. A subsurface tile system laid in such a way that effluent from the septic tank is distributed reasonably uniformly into the natural soil is assumed when applying this guide. A rating of poor need not mean that a septic system should not be installed in the given soil, but rather, may suggest the difficulty, in terms of installation and maintenance, which can be expected.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
k	Permeability[2]	Rapid to moderately rapid	Moderate	Slow	Very slow
	Percolation Rate[3] (Auger hole method)	About 8-18 min/cm[3]	18-24 min/cm	Slower than 24 min/cm	
h	Depth to Seasonal Water Table[4]	>150 cm[5]	100-150 cm	50-100 cm	<50 cm
i	Flooding	Not subject to flooding	Not subject to flooding	Subject to occasional flooding (once in 5 years)	Floods every year
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Hard Rock, bedrock or other impervious materials	>150 cm	100-150 cm[6]	50-100 cm	<50 cm

1/ The symbols are used to indicate the nature of the limitation.

2/ The suitability ratings should be related to the permeability of soil layers at and below depth of the tile line.

3/ Soils having a percolation rate less than about 8 min/cm are likely to present a pollution hazard to adjacent waters. This hazard must be noted, but the degree of hazard must, in each case, be assessed by examining the proximity of the proposed installation to water bodies, water table, and related features. The symbol g is used to indicate this condition. Refer to U.S. Dept. of Health, Education and Welfare (1969) for details of this procedure.

4/ Seasonal means for more than one month. It may, with caution, be possible to make some adjustment for the severity of a water table limitation in those cases where seasonal use of the facility does not coincide with the period of high water table.

5/ A seasonal water table should be at least 100 cm below the bottom of the trench at all times for soils rated Good (U.S. Dept. of Health, Education and Welfare, 1969). The depths used to water table are based on an assumed tile depth of 50 cm. Where relief permits, the effective depth above a water table or rock can be increased by adding appropriate amounts of fill.

6/ Where the slope is greater than 9%, a depth to bedrock of 100-150 cm is assessed as poor.

TABLE 22

Guide for assessing soil suitability for playgrounds

This guide applies to soils to be used intensively for playgrounds for baseball, football, badminton, and for other similar organized games. These areas are subject to intensive foot traffic. A nearly level surface, good drainage, and a soil texture and consistence that gives a firm surface generally are required. The most desirable soils are free of rock outcrops and coarse fragments.

Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Rapidly, well and moderately well drained soils with no ponding or seepage. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding of short duration and imperfectly drained soils. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding, and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	Occasional flooding. May flood once every 2-3 years during season of use.	Floods every year during season of use.	Prolonged flooding during season of use.
k	Permeability	Very rapid to moderate.	Moderately slow and slow.	Very slow.	
t	Slope	0-2%	2-5%	5-9%	>9%
d	Depth to Bedrock	>100 cm	50-100 cm[3]	<50 cm[3]	
c	Coarse fragments on surface[2]	Relatively free of coarse fragments.	<20% coarse fragments.	>20% coarse fragments.	
p	Stoniness[2]	Stones >10 m apart. (Class 0 to 1)	Stones 2-10 m apart. (Class 2)	Stones 0.1-2 m apart. (Class 3, 4)	Stones <0.1 m apart. (Class 5)
r	Rockiness[2]	Rock exposures >100 m apart and cover <2% of the surface.	Rock exposures 30-100 m apart and cover about 2-10% of the surface.	Rock exposures <30 m apart and cover >10% of the surface.	Rock outcrops too frequent to permit playground location.
s	Surface Soil Texture[2],[4]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS	SC, SiC, C[5]; S, Si	Peaty soils; S and LS subject to blowing.
q	Depth to Sand or Gravel[6]	>100 cm	50-100 cm	<50 cm	
m	Useful Moisture[7]	Water storage capacity[8] >15.0 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

1/ The symbols are used to indicate the nature of the limitation.

2/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).
Coarse fragments for the purpose of this table include gravels and cobbles.

3/ Downgrade to a very poor suitability rating if the slope is greater than 5%.

4/ Surface soil texture influences soil ratings as it affects foot trafficability, surface wetness, dust, and maintenance. Adverse soil textures may be partially or completely overcome with the addition of topsoil.

5/ Moderately well and well drained SC, SiC and C soils may be rated fair.

6/ Depth to sand or gravel is considered a limitation in that levelling operations may expose sand or gravel, thereby bringing about adverse surface textures and undesirable amounts of coarse fragments. The addition of topsoil after the levelling process would overcome this limitation.

7/ This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

8/ Consult glossary for definitions of terms used.

TABLE 23

Guide for assessing soil suitability for picnic areas

This guide applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to the access roads. Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils not subject to seepage or ponding. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils not subject to ponding or seepage. Water Table above 50 cm for short periods during season of use.	Imperfectly drained soils subject to seepage or ponding. Poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	May flood 1 or 2 times per year for short periods during season of use.	Floods more than 2 times during season of use.	Prolonged flooding during season of use.
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2],[3]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2]	0-20%	20-50%	>50%	
p	Stoniness[2]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[2],[5],[6]	Rock exposures roughly 30-100 or more m apart and cover <10% of the surface.	Rock exposures roughly 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of picnic areas.
m	Useful Moisture[7]	Water storage capacity[8] >15 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978). Coarse fragments for the purpose of this table, include gravels and cobbles. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[3] Surface soil texture influences soil ratings as it affects foot trafficability, dust and soil permeability.

[4] Moderately well and well drained SC, SiC and C soils may be rated fair.

[5] Very shallow soils are rated as having severe or very severe limitations for stoniness or rockiness.

[6] The nature and topography of the bedrock exposures may significantly alter these ratings. As such, on-site investigations will be necessary in map units containing bedrock when these are considered as possible sites.

[7] This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

[8] Consult glossary for definitions of terms used.

TABLE 24

Guide for assessing soil suitability for camp areas

This guide applies to soils to be used intensively for tents and camp trailers and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and levelling for campsites and parking areas. The soil should be suitable for heavy foot traffic by humans and limited vehicular traffic. Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of site.

Back country campsites differ in design, setting and management but require similar soil attributes. These guides should apply to evaluations for back country campsites but depending on the nature of the facility the interpreter may wish to adjust the criteria defining a given degree of limitation to reflect the changed requirement. For example, small tentsites may allow rock exposures greater than 10 m apart to be considered a slight limitation.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils with no seepage or ponding. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils with no seepage or ponding. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None	Very occasional flooding during season of use. Once in 5-10 years.	Occasional flooding during season of use. Once in 2-4 years.	Flooding during every season of use.
k	Permeability	Very rapid to moderate inclusive.	Moderately slow and slow.	Very slow.	
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2],[3]	SL, FSL, VFSL, L	SiL, SCL, CL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2],[5]	0-20%	20-50%	>50%	
p	Stoniness[2],[6]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
r	Rockiness[2],[6]	No rock exposures	Rock exposures >10 m apart and cover <25% of the area.	Rock exposures <10 m apart and cover >25% of the area.	Rock exposures too frequent to permit campground location.

[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Surface soil texture influences soil ratings as it affects foot trafficability, dust, and soil permeability.

[4] Moderately well and well drained SC, SiC and C soils may be rated fair.

[5] Coarse fragments for the purpose of this table include gravels and cobbles. Some gravelly soils may be rated as having slight limitations if the content of gravel exceeds 20%, by only a small margin, providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[6] Very shallow soils are rated as having a limitation for rockiness and/or stoniness.

TABLE 25

Guide for assessing soil suitability for paths and trails

It is assumed that the trails will be built at least 45 cm wide and that obstructions such as cobbles and stones will be removed during construction. It is also assumed that a dry, stable tread is desirable and that muddy, dusty, worn or eroded trail treads are undesirable. Hiking and riding trails are not treated separately, but as the design requirements for riding trails are more stringent, a given limitation will be more difficult to overcome. Poor or very poor suitability does not indicate that a trail cannot or should not be built. It does, however, suggest higher design requirements and maintenance to overcome the limitations.

Symbol[1]	Items[2] Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Texture[3],[4]	SL, FSL, VFSL, LS, L	SiL, CL, SiCL, SCL	SC, SiC, C[5]; Sand, SI	Peaty soils; loose sand subject to blowing
c	Coarse Fragment Content[4],[6]	0-20%	20-50%	>50%	
p	Stoniness[4]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
w	Wetness[4]	Very rapidly, rapidly well, and moderately well drained soils. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage and ponding and imperfectly drained soils. Water table may be above 50 cm for short periods during season of use.	Poorly and very poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Permanently wet soils.
r	Rockiness[4],[7]	Rock exposures >30 m apart and cover <10% of the surface.	Rock exposures 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of paths and trails.
t	Slope[8]	0-15%	15-30%	30-60%	>60%
i	Flooding	Not subject to flooding during season of use.	Floods 1 or 2 times during season of use.	Floods more than 2 times during season of use.	Subject to prolonged flooding during season of use.

1/ The symbols are used to indicate the nature of the limitation.

2/ The items affecting use listed in this table are those which have been shown to cause significant differences in trail response. Elevation, aspect, position on slope, and snow avalanching may have slight effects or influence trail management and should be considered in the final site evaluation. Items such as vegetation, fauna, and scenic value are not considered in the guidelines (Epp, 1977).

3/ Texture refers to the soil texture which will form the tread texture. This is the surface texture on level areas but may be a subsurface texture on slopes. Textural classes are based on the less than 2 mm soil fraction. Texture influences soil ratings as it influences foot trafficability, dust, design or maintenance of trails, and erosion hazards.

4/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Moderately well and well drained SC, SiC and C soils may be rated fair.

6/ Coarse fragments for the purpose of this table, include gravels and cobbles. Gravels tend to cause unstable footing when present in high amounts, and are also associated with increased erosion. Cobbles (and stones) must be removed from the trail tread, increasing construction and maintenance difficulties. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix or (b) the fragments are less than 2 cm in size.

7/ The type of rock outcrop (flat lying vs cliffs), and the orientation of the structure (linear cliffs vs massive blocks) can greatly alter the degree of the limitation. Each site with a Rockiness limitation based on the percent rock outcrop above should be evaluated on its own merits and the degree of limitation should then be modified appropriately if necessary.

8/ Slope in this context refers to the slope of the ground surface, not the slope of the tread.

Appendix C

GLOSSARY

AASHO classification (soil engineering) - The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

Acid soil - A soil having a pH less than 7. See pH and Reaction, soil.

Alkaline soil - A soil having a pH greater than 7. See Reaction, soil.

Alluvium - A general term for all deposits of rivers and streams.

Arable soil - Soil suitable for plowing and cultivation.

Association - A sequence of soils of about the same age, derived from similar parent material, and occuring under similar climatic conditions but showing different characteristics due to variations in relief and in drainage.

1/3 Atmosphere Moisture - The moisture percentage on dry weight basis of a soil sample that has been air dried, screened, saturated and subjected to a soil moisture tension of 345 cm of water through a permeable membrane for a period of 48 hours. It approximates the soil moisture retention capacity.

Available nutrient - That portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

Available soil moisture - The portion of water in a soil that can be readily absorbed by plant roots: generally considered to be that water held in the soil up to approximately 15 atmospheres pressure.

Bearing capacity - Capacity of soil (in moist to wet conditions) to support loads such as buildings, people, vehicles, and animals.

Bedrock - The solid rock that underlies soil and regolith or that is exposed at the surface.

Boulders - Stones which are larger than 60 cm in diameter.

Bulk density - The weight of oven dry soil (105 degrees C) divided by its volume at field moisture conditions, expressed in grams per cubic centimeter.

Buried soil - Soil covered by an alluvial, loessial, or other deposit, usually to a depth greater than the thickness of the solum.

Calcareous soil - Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with hydrochloric acid.

Calcium Carbonate Equivalent - Refers to the percent of carbonates in

the soil expressed on the basis of calcium carbonate. Terms used to express the carbonate contents of soils are:

noncalcareous	<1%
weakly calcareous	1-5%
moderately calcareous	6-15%
strongly calcareous	16-25%
v. strongly calcareous	26-40%
extremely calcareous	>40%

Capillary fringe - A zone of essentially saturated soil just above the water table. The size distribution of the pores determines the extent and degree of the capillary fringe.

Carbon-nitrogen ratio (C/N ratio) - The ratio of the weight of organic carbon to the weight of total nitrogen in a soil or in an organic material.

Cation Exchange Capacity (CEC) - A measure of the total amount of exchangeable cations that can be held by a soil. Expressed in milliequivalents per 100g of soil.

Clay - As a soil separate, the mineral soil particles less than 0.002 mm in diameter: usually consisting largely of clay minerals. As a soil textural class, soil materials that contain 40 or more percent clay, less than 45 percent sand and less than 40 percent silt.

Cobbles - Rock fragments 8 to 25 cm in diameter.

Color - Soil colors are compared with a Munsell color chart. The Munsell system specifies the relative degrees of the three simple variables of color: hue, value and chroma. For example: 10YR 6/4 means a hue of 10YR, a value of 6, and a chroma of 4.

Complex (soil) - A mapping unit used in detailed and reconnaissance soil surveys where two or more soil series that are so intimately intermixed in an area that it is impractical to separate them at the scale of mapping used.

Concretions - Hard grains, pellets or nodules from concentration of compounds in the soil that cement soil grains together.

Conductivity, electrical - A physical quantity that measures the readiness with which a medium (irrigation water and soil extracts) transmits electricity. It expresses the concentration of salt in terms of the conductance (reciprocal of the electric resistance in ohms) in millisiemens per cm.

Consistence (soil) - The mutual attraction of the particles in a soil mass, or their resistence to separation or deformation. It is described in terms such as loose, soft, friable, firm, hard, sticky, plastic or cemented.

Consumptive use factor (CU) - The ratio of consumptive use of water by a crop to potential evapotranspiration. and transpiration. An actively growing crop that completely covers the soil over a large area and that has an ample supply of readily available soil water has a consumptive use factor of 1.0.

Consumptive use of water - The sum of the depths of water transpired by the plants and evaporated from the soil surface and from intercepted precipitation. It may be less or greater than potential evapotranspiration.

Contour - An imaginary line connecting points of equal elevation on the surface of the soil.

Cover - This term generally has one of the following meanings:

1. Vegetation or other material providing protection

2. In forestry, low growing shrubs and herbaceous plants under trees (i.e., ground cover vs. tree cover)

3. Any vegetation producing a protective mat on or just above the soil surface.

Creep (soil) - Slow mass movement of soil and soil material down rather steep slopes primarily under the influence of gravity, but aided by saturation with water and by alternate freezing and thawing.

Decile portion - A one-tenth portion. As used in the soil map symbol A7-B3 means that the A soils cover seven tenths and the B soils cover three tenths of the map unit.

Delta - A fluvial or glaciofluvial fan shaped deposit at the mouth of a river that empties into a lake or sea.

Deflocculate - To separate or to break up soil aggregates into individual particles by chemical or physical means or both.

Degradation (of soils) - The changing of a soil to a more highly leached and more highly weathered condition, usually accompanied by morphological changes such as the development of an eluviated light colored (Ae) horizon.

Dispersion - Is rated high, moderate or low depending on how readily the soil structure breaks down or slakes because of excess moisture. A rating of high indicates that soil aggregates slake readily; a rating of low indicates that aggregates are resistant to dispersion and remain clumped together.

Drainage (soil) - (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (2) As a condition of the soil, it refers to the frequency and duration of periods when the soil is free of saturation.

Drainage in soil reports is described on the basis of actual moisture content in excess of field capacity and length of the saturation period within the plant root zone. The terms are as follows:

Very rapidly drained - Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Rapidly drained - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (2.5-4 cm) within the control section, and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Well drained - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are equaled by losses. These soils are usually free of mottles within 100 cm of the surface but may be mottled below this depth. Soil horizons are usually bright colored.

Moderately well drained - Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6cm) within the control section and are usually medium to fine in texture. Soils are commonly mottled in the 50 to 100 cm depth. Colors are dull brown in the subsoil with stains and mottles.

Imperfectly drained - Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is major supply. If subsurface water or groundwater, or both, is the main source, flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface flow or groundwater flow, or both, increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are gleyed phases of well drained subgroups. These soils generally have mottling below the surface layers and generally have duller colors with depth, generally brownish gray with mottles of yellow and gray.

Poorly drained - Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are main water sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Poorly drained soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups, Gleysols, and Organic soils.

Very poorly drained - Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration. These soils have a wide range in available water storage capacity, texture, and depth, and are either Gleysolic or Organic.

Dryland farming - The practice of crop production in low rainfall areas without irrigation.

Eluvial horizon - A horizon from which material has been removed in solution or in water suspension.

Eolian - Soil material accumulated through wind action.

Erosion - The wearing away of the land surface by detachment and transport of soil and rock material through the action of moving water, wind or other geological processes. The ratings of erosion are:

Erosion 1 slightly eroded - soil with a sufficient amount of the A horizon removed that ordinary tillage will bring up and mix the B horizon or other lower lying horizons with surface soil in the plow layer.

Erosion 2 moderately eroded - soil with all of the A horizon and a part of the B or other lower lying horizons removed. The plow layer consists mainly of the original horizons below the A or below the original plow layer.

Erosion 3 severely eroded - soils have practically all of the original surface soil removed. The plow layer consists mainly of C horizon material, especially on knolls and steep upper slope positions.

Evapotranspiration - The combined loss of water from a given area, and during a specific period of time, by evaporation from the soil surface and transpiration from plants.

Field Moisture Equivalent - The minimum moisture content at which a drop of water placed on a smoothed surface of the soil will not be absorbed immediately by the soil, but will spread out over the surface and give it a shiny appearance.

Flood plain - The land bordering a stream, built up of sediments from overflow of the stream and subject to inundation when the stream is at flood stage.

Fluvial deposits - All sediments past and present, deposited by flowing water, including glaciofluvial deposits.

Frost heave - The raising of the surface caused by ice in the subsoil.

Friable - Soil aggregates that are soft and easily crushed between thumb and forefinger.

Glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. These deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers and kame terraces.

Gleyed soil - An imperfectly or poorly drained soil in which the material has been modified by reduction or alternating reduction and oxidation. These soils have lower chromas or more prominent mottling or both in some horizons than the associated well-drained soil.

Gleysolic - An order of soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas or prominent mottling or both, in some horizons.

Gravel - Rock fragments 2 mm to 7.5 cm in diameter.

Ground Moraine - An unsorted mixture of rocks, boulders, sand, silt and clay deposited by glacial ice. The predominant material is till; most till is thought to have accumulated under the ice by lodgment, but some till has been let down from the upper surface of the ice by ablation. Resorting and modification may have taken place to some extent by wave-action of glacial melt waters. The topography is most commonly in the form of undulating plains with gently sloping hills and enclosed depressions.

Groundwater - Water beneath the soil surface, usually under conditions where the voids are completely filled with water (saturation).

Halophytic vegetation - vegetation that grows naturally in soils having a high content of various salts. It usually has fleshy leaves or thorns and resembles desert vegetation.

Horizon (soil) - A layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil forming processes.

Horizon boundary - The lower boundary of each horizon is described by indicating its distinctness and form. The distinctness depends on the abruptness of vertical change (thickness). The form refers to the variation of the boundary plane.

Distinctness -
abrupt - less than 2 cm
clear - 2 to 5 cm
gradual - 5 to 15 cm
diffuse - more than 15 cm

Form -
smooth - nearly plain
wavy - pockets are wider than deep
irregular - pockets are deeper than wide
broken - parts of the horizon are unconnected with other parts

Humic layer - A layer of highly decomposed organic soil material containing little fibre.

Hydraulic Conductivity - Refers to the effective flow velocity or discharge velocity in soil at unit hydraulic gradient. It is an approximation of the permeability of the soil and is expressed in cm per hour. The classes are described in general or specific terms as:

High	>15	Very rapid	>50
		Rapid	15-50
Medium	0.5-15	Mod. rapid	5.0-15
		Moderate	1.5-5.0
		Mod. slow	0.5-1.5
Low	<0.5	Slow	0.15-0.5
		Very slow	0.015-0.15
		Extremely slow	<.015

Hydrologic cycle - The conditions through which water naturally passes from the time of precipitation until it is returned to the atmosphere by evaporation and is again ready to be precipitated.

Hydrophyte - Plants growing in water or dependent upon wet or saturated soil conditions for growth.

Illuvial horizon - A soil horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. The layer of accumulation.

Impeded drainage - A condition that hinders the movement of water by gravity through the soils.

Inclusion - Soil type found within a mapping unit that is not extensive enough to be mapped separately or as part of a complex.

Infiltration - The downward entry of water into the soil

Irrigation - The artificial application of water to the soil for the benefit of growing crops.

Irrigation requirement (IR) - Refers to the amount of water exclusive of effective precipitation that is required for crop production.

Lacustrine deposits - Material deposited by or settled out of lake waters and exposed by lowering of the water levels or elevation of the land. These sediments range in texture from sand to clay and are usually varved (layered annual deposits).

Landforms - See Description of Landforms

Landscape - All the natural features such as fields, hills, forest, water, etc., which distinguish one part of the earth's surface from another part.

Leaching - The removal from the soil of materials in solution.

Liquid limit (upper plastic limit) - The water content corresponding to an arbitrary limit between the liquid and plastic states of consistency of a soil. The water content at this boundary is defined as that at which a pat of soil cut by a groove of standard dimensions will flow together for a distance of 1.25 cm under the impact of 25 blows in a standard liquid limit apparatus.

Lineal shrinkage - This is the decrease in one dimension expressed as a percentage of the original dimension of the soil mass when the moisture content is reduced from a stipulated percentage (usually field moisture equivalent) to the shrinkage limit.

Mapping Unit - Any delineated area shown on a soil map that is identified by a symbol. A mapping unit may be a soil unit, a miscellaneous land type, or a soil complex.

Marsh - Periodically flooded or continually wet areas having the surface not deeply submerged. It is covered dominantly with sedges, cattails, rushes or other hydrophytic plants.

Mature soil - A soil having well-developed soil horizons produced by the natural processes of soil formation.

Mesophyte - Plants requiring intermediate moisture conditions and are not very resistant to drought.

Microrelief - Small-scale, local differences in relief including mounds, swales or hollows.

Milliequivalent (me) - One-thousandth of an equivalent. An equivalent is the weight in grams of an ion or compound that combines with or replaces one gram of hydrogen. The atomic or formula weight divided by valence.

Mottles - Irregularly marked spots or streaks, usually yellow or orange but sometimes blue. They are described in order of abundance (few, common, many), size (fine, medium, coarse) and contrast (faint, distinct, prominent). Mottles in soils indicate poor aeration and lack of good drainage.

Organic carbon - Carbon derived from plant and animal residues.

Organic matter - The fraction of the soil which consists of plant and animal residues at various stages of decomposition, cells and tissues of soil organisms and substances synthesized by the soil population. It is determined on soils that have been sieved through a 2.0 mm sieve. It is estimated by multiplying the organic carbon by a factor of 1.72.

Outwash - Sediments "washed out" beyond the glacier by flowing water and laid down in thin beds or strata. Particle size may range from boulders to silt.

Ovendry soil - Soil that has been dried at 105 degrees C until it has reached constant weight.

Parent material - The unaltered or essentially unaltered mineral or organic material from which the soil profile develops by pedogenic processes.

Particle size, soil - The grain size distribution of the whole soil including the coarse fraction. It differs from texture, which refers to the fine earth (less than 2mm) fraction only. In addition, textural classes are usually assigned to specific horizons whereas soil family particle-size classes indicate a composite particle size of a part of the control section that may include several horizons. See Textural Triangle at end of Glossary.

The particle-size classes for family groupings are as follows:

Fragmental Stones, cobbles and gravel, with too little fine earth to fill interstices larger than 1 mm.

Sandy-skeletal Particles coarser than 2 mm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the sandy particle-size class.

Loamy-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the loamy particle-size class.

Clayey-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the clayey particle-size class.

Sandy The texture of the fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures; particles 2 mm- 25 cm occupy less than 35% by volume.

Loamy The texture of the fine earth includes loamy very fine sand, very fine sand, and finer textures with less than 35% clay; particles 2 mm-25 cm occupy less than 35% by volume.

Coarse-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm)

or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Coarse-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Clayey. The fine earth contains 35% or more clay by weight and particles 2mm-25 cm occupy less than 35% by volume.

Fine-clayey. A clayey particle size that has 35-60% clay in the fine earth fraction.

Very-fine-clayey. A clayey particle size that has 60% or more clay in the fine earth fraction.

Ped - An individual soil aggregate such as granule, prism or block formed by natural processes (in contrast with a clod which is formed artificially).

Pedology - Those aspects of soil science involving constitution, distribution, genesis and classification of soils.

Percolation - The downward movement of water through soil; specifically, the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of 1.0 or less.

Permafrost -

1. Perennially frozen material underlying the solum.

2. A perennially frozen soil horizon.

Permafrost table - The upper boundary of permafrost, usually coincident with the lower limit of seasonal thaw (active layer).

Permeability - The ease with which water and air pass through the soil to all parts of the profile. See hydraulic conductivity.

pH - The intensity of acidity and alkalinity, expressed as the negative logarithm of the hydrogen ion concentration. A pH of 7 is neutral, lower values indicate acidity and higher values alkalinity (see Reaction, soil).

Phase, soil - A soil phase is used to characterize soil and landscape properties that are not used as criteria in soil taxonomy. The major phase differentiae are: slope, erosion, deposition, stoniness, texture, salinity, and calcareousness.

Plastic Limit - The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of a soil.

Plasticity Index - The numerical difference between the liquid and the plastic limit. The plasticity index gives the range of moisture contents within which a soil exhibits plastic properties.

Potential evapotranspiration (PE) - The maximum quantity of water capable of being lost as water vapor, in a given climate, by a continuous stretch of vegetation covering the whole ground and well supplied with water.

Profile, soil - A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil - The acidity or alkalinity of a soil. Soil reaction classes are characterized as follows:

extremely acid	pH <4.5
very strongly acid	4.5 to 5.0
strongly acid	5.1 to 5.5
medium acid	5.6 to 6.0
slightly acid	6.1 to 6.5
neutral	6.6 to 7.3
mildly alkaline	7.4 to 7.8
mod. alkaline	7.9 to 8.4
strongly alkaline	8.5 to 9.0
very strongly alkaline	>9.0

Regolith - The unconsolidated mantle of weathered rock and soil material on the earth's surface.

Relief - The elevation of inequalities of the land surface when considered collectively.

Runoff - The portion of the total precipitation on an area that flows away through stream channels. Surface runoff does not enter the soil. Groundwater runoff or seepage flow from groundwater enters the soil before reaching the stream.

Saline Soil - A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 millisiemens/cm (ms/cm), the exchangeable-sodium percentage is less than 15, and the pH is usually less than 8.5. Approximate limits of salinity classes are:

non-saline	0 to 4 ms/cm
weakly saline	4 to 8 mS/cm
mod. saline	8 to 15 ms/cm
strongly saline	>15 ms/cm

Salinization - The process of accumulation of salts in the soil.

Salt-Affected Soil - Soil that has been adversely modified for the growth of most crop plants by the presence of certain types of exchangeable ions or of soluble salts. It includes soils having an excess of salts, or an excess of exchangeable sodium or both.

Sand - A soil particle between 0.05 and 2.0 mm in diameter. The textural class name for any soil containing 85 percent or more of sand and not more than 10 percent of clay.

Saturation Percentage - The moisture percentage of a saturated soil paste, expressed on an oven dry weight basis.

Seepage -

1. The escape of water downward through the soil.

2. The emergence of water from the soil along an extensive line of surface in contrast to a spring where water emerges from a local spot.

Series, soil - A category in the Canadian System of Soil Classification. It consists of soils that have soil horizons similar in their differentiating characteristics and arrangement in the profile, except for surface tex-

ture and are formed from a particular type of parent material.

Shrinkage limit - This is the moisture content at which an equilibrium condition of volume change is reached and further reduction in moisture content will not cause a decrease in the volume of the soil mass.

Shrinkage ratio - This is the ratio between the volume change and a corresponding change in moisture content. It equals the apparent specific gravity of the dried soil.

Silt - (a) Individual mineral particles of soil that range in diameter between 0.05 to .002 mm. (b) Soil of the textural class sil. contains greater than 80 percent silt and less than 12 percent clay.

Slickenside - Smoothed surfaces along planes of weakness resulting from the movement of one mass of soil against another in soils dominated by swelling clays.

Sodium-Adsorption Ratio (S.A.R.) - A ratio for soil extracts and irrigation waters used to express the relative activity of sodium ions in exchange reactions with other cations in the soil $SAR = Na/((Ca+Mg)/2)^{1/2}$ where the cation concentrations are expressed as milliequivalents per litre.

Soil - The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effects), macro- and micro-organisms, and topography, all acting over a period of time.

Solum - The upper horizons of a soil above the parent material and in which the processes of soil formation are active. It usually comprises the A and B horizons.

Stones - Rock fragments greater than 25 cm in diameter.

Stoniness - The percentage of land surface occupied by stones. The classes of stoniness are defined as follows:

Stones 0. Nonstony -- Land having less than 0.01% of surface occupied by stones.

Stones 1. Slightly stony -- Land having 0.01-0.1% of surface occupied by stones. Stones 15-30 cm in diameter, 10-30 m apart. The stones offer only slight to no hindrance to cultivation.

Stones 2. Moderately stony -- Land having 0.1-3% of surface occupied by stones. Stones 15-30 cm in diameter, 2-10 m apart. Stones cause some interference with cultivation.

Stones 3. Very stony -- Land having 3-15% of surface occupied by stones. Stones 15-30 cm in diameter, 1-2 m apart. There are sufficient stones to constitute a serious handicap to cultivation.

Stones 4. Exceedingly stony -- Land having 15-50% of surface occupied by stones. Stones 15-30 cm in diameter, 0.7-1.5 m apart. There are sufficient stones to prevent cultivation until considerable clearing has been done.

Stones 5. Excessively stony -- Land having more than 50% of surface occupied by stones. Stones 15-30 cm in diameter, less than 0.7 m apart. The land is too stony to permit cultivation.

Storage Capacity - Refers to the maximum amount of readily available water that can be stored within the rooting zone of a crop in a given soil. For practical irrigation purposes, 50 percent of the total soil water between field capacity and wilting point may be considered as readily available.

Stratified materials - Unconsolidated sand, silt and clay arranged in strata or layers. In stratified materials, a bed is a unit layer distinctly separable from other layers and is one or more cm thick but a lamina is a similar layer less than 1 cm thick.

Structure - The combination or arrangement of primary soil particles into aggregates of secondary soil particles, units or peds, which are separated from each other by surfaces of weakness. Structure is expressed in terms of grade, size class and shape type. Grade refers to the distinctness of aggregate development, and is described as structureless, weak, moderate or strong. Structureless refers to the absence of observable aggregation of definite orderly arrangement; the term amorphous is used if soil is massive or coherent, single-grained if noncoherent. The weak to strong aggregates vary in size and are described by class as fine, medium, coarse, and very coarse depending on the shape types. The shape types refers to the dominant configuration of the aggregates and the way they are accommodated. The general shape types are plate-like, block-like and prism-like. The terms are:

Platy - Having thin, plate-like aggregates with faces mostly horizontal

Prismatic - Having prism-like aggregates with tops and edges, appear plane, level and somewhat angular.

Columnar - Having prism-like aggregates with vertical edges near the top of columns, not sharp.

Granular - Having block-like aggregates that appear as spheroids or polyhedrons having plane or curved surfaces which have slight or no accommodation to the faces of the surrounding peds.

Blocky - Having block-like aggregates with sharp, angular corners

Subangular blocky - Having block-like aggregates with rounded and flattened faces and rounded corners.

By convention an aggregate is described in the order of grade, class and type, e.g. strong, medium, blocky. In the parent material of soils the material with structural shapes may be designated as pseudo-blocky, pseudo-platy, etc.

Soil Survey - The systematic examination, description, classification, and mapping of soil in an area.

Sulfate Hazard - Refers to the relative degree of attack on concrete by soil and water containing various amounts of sulfate ions. It is estimated from electrolyte measurements and salt analysis on selected profiles and soil samples, and by visual examination of free gypsum within the profile during the course of soil investigation.

Swamp - See Description of Landforms

Texture, soil - The relative proportions of the fine earth (less than 2 mm.) fraction of a soil. Textural classes are usually assigned to specific horizons whereas family particle size classes indicate a composite particle size of a portion of the control section that may include several horizons. See Texture Triangle at end of Glossary.

The size range of the constituent primary particles are as follows:

	Diameter (mm)
Very coarse sand	2.0-1.0
Coarse sand	1.0-0.5
Medium sand	0.5-0.25
Fine sand	0.25-0.10
Very fine sand	0.10-0.05
Silt	0.05-0.002
Clay	< 0.002
Fine clay	< 0.0002

Till, glacial - Unstratified glacial deposits consisting of clay, sand, gravel, and boulders intermingled in any proportion.

Tilth - The physical condition of soil as related to its ease of tillage, fitness as a seedbed, and its impedance to seedling emergency and root penetration.

Topography - Refers to the percent slope and the pattern or frequency of slopes in different directions. A set of 10 slope classes are used to denote the dominant but not necessarily most abundant slopes within a mapping unit.

Slope Class	Slope Name	Percent slope	Approx. degrees
1	level	0-0.5	0
2	nearly level	.5-2.5	.3-1.5
3	very gentle	2-5	1-3
4	gentle	6-9	3.5-5
5	moderate	10-15	6-8.5
6	strong	16-30	9-17
7	very strong	31-45	17-24
8	extreme	46-70	25-35
9	steep	71-100	35-45
10	very steep	>100	>45

Underground runoff - (or seepage)-Water flowing towards stream channels after infiltration into the ground.

Unified Soil Classification System (engineering) - A classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

Urban Land - Areas so altered or obstructed by urban works or structures that identification of soils is not feasible.

Variant, soil - A soil whose properties are believed to be sufficiently different from other known soils to justify a new series name, but comprising such a limited geographic area that creation of a new series is not justified.

Varve - A distinct band representing the annual deposit in sedimentary materials regardless of origin and usually consisting of two layers, one thick light colored layer of silt and fine sand laid down in the spring and summer, and the other a thin, dark colored layer of clay laid down in the fall and winter.

Water balance, soil - Is the daily amount of readily available water retained by the soil. The daily soil-water balance is decreased by the amount that the daily consumptive use exceeds the daily rainfall. When daily rainfall exceeds the consumptive use, the daily balance increases by the amount of the difference unless the soil-water balance is at storage capacity, in which case the excess is assumed to be lost by runoff or deep percolation.

Water table - (groundwater surface; free water surface; groundwater elevation) Elevation at which the pressure in the water is zero with respect to the atmospheric pressure.

Water-holding capacity - The ability of a soil to hold water against the force of gravity in a freely drained soil.

Weathering - The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

Xerophyte - Plants capable of surviving extended periods of soil drought.

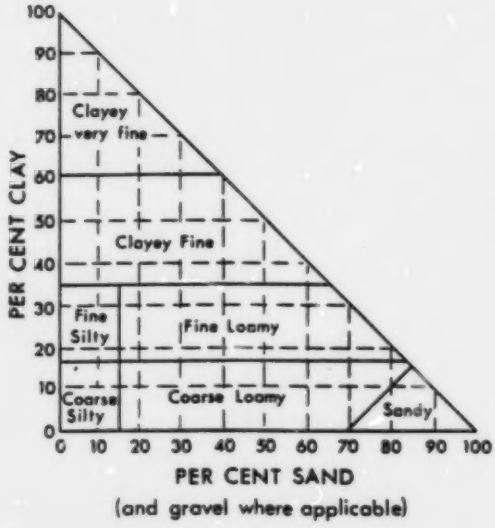
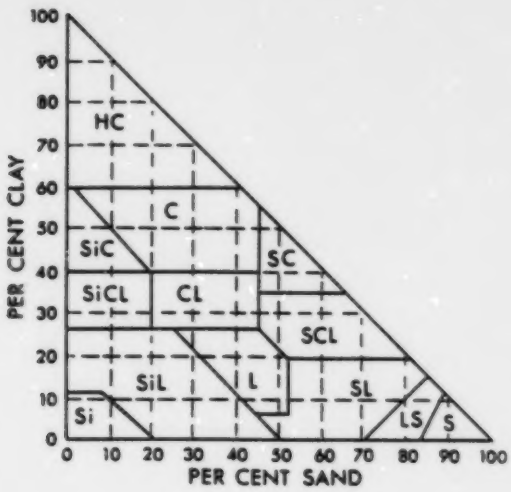


Figure 6: Family particle-size classes.



Texture Group	Class Symbol	Class Name
Coarse	S	sand
	LS	loamy sand
Moderately coarse	SL	sandy loam
	LVFS	loamy very fine sand
Medium	Si	silt
	SiL	silt loam
	L	loam
	VFSL	very fine sandy loam
Moderately fine	SCL	sandy clay loam
	CL	clay loam
	SiCL	silty clay loam
Fine	SC	sandy clay
	C	clay
	SiC	silty clay
Very fine	HC	heavy clay

Figure 7: Soil Textural Classes.

Appendix D

SOIL HORIZON DESIGNATIONS

ORGANIC HORIZONS

Organic horizons are found in Organic soils, and commonly at the surface of mineral soils. They may occur at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon (approximately 30% organic matter) by weight. Two groups of these horizons are recognized, O horizons and the L, F, and H horizons.

O This is an organic horizon developed mainly from mosses, rushes, and woody materials.

Of The fibric horizon is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fiber that are readily identifiable as to botanical origin. A fibric horizon has 40% or more of rubbed fiber by volume and a pyrophosphate index of 5 or more. If the rubbed fiber volume is 75% or more, the pyrophosphate criterion does not apply.

Om The mesic horizon is the intermediate stage of decomposition with intermediate amounts of fiber, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic horizon is one that fails to meet the requirements of fibric or humic.

Oh The humic horizon is the most highly decomposed of the organic soil materials. It has the least amount of fiber, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes very little physically or chemically with time unless it is drained. The humic horizon has less than 10% rubbed fiber by volume and a pyrophosphate index of 3 or less.

LFH These organic horizons developed primarily from leaves, twigs, woody materials and a minor component of mosses under imperfectly to well drained forest conditions.

L This is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible.

F This is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor.

H This is an organic horizon characterized by an accumulation of decomposed organic

matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with the mineral horizon.

MASTER MINERAL HORIZONS

Mineral horizons are those that contain less than 30% organic matter by weight as specified for organic horizons.

A This is a mineral horizon or horizons formed at or near the surface in the zone of leaching or removal of materials in solution and suspension or of maximum in situ accumulation of organic matter, or both. Included are:

1. horizons in which organic matter has accumulated as a result of biological activity (Ah);

2. horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of them (Ae);

3. horizons having characteristics of 1) and 2) above but transitional to underlying B or C (AB or A and B);

4. horizons markedly disturbed by cultivation or pasture (Ap).

B This is a mineral horizon or horizons characterized by one or more of the following:

1. an enrichment in silicate clay, iron, aluminum, or humus, alone or in combination (Bt,Bf,Bfh,Bhf, and Bh);

2. a prismatic or columnar structure that exhibits pronounced coatings or stainings and significant amount of exchangeable Na (Bn);

3. an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both, and does not meet the requirements of 1) and 2) above (Bm,Bg).

C This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (i) the process of gleying, and (ii) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca,Csa,Cg, and C). Marl and diatomaceous earth are considered to be C horizons.

R This is consolidated bedrock that is too hard to break with the hands or to dig with a spade when moist and that does not meet the requirement of a C horizon. The boundary between the R layer and overlying unconsolidated material is called a lithic contact.

W This is a layer of water in Gleysolic, Organic, or Cryosolic soils. It is called a hydric layer in Organic soils.

LOWER-CASE SUFFIXES

b Buried soil horizon.

c A cemented (irreversible) pedogenic horizon. The ortstein of a Podzol, and a layer cemented by calcium carbonate and a duripan are examples.

ca A horizon with secondary carbonate enrichment where the concentration of lime exceeds that present in the unenriched parent material. It is more than 10 cm thick, and if it has a CaCO3 equivalent of less than 15 percent it should have at least 5 percent more CaCO3 equivalent than the parent material (IC). If it has more than 15 percent CaCO3 equivalent it should have 1/3 more CaCO3 equivalent than the IC. If no IC is present, this horizon is more than 10 cm thick and contains more than 5 percent by volume of secondary carbonates in concretions or soft, powdery forms.

cc Cemented (irreversible) pedogenic concretions.

e A horizon characterized by the eluviation of clay, iron, aluminum, or organic matter alone or in combination. When dry, it is usually higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae).

f A horizon enriched with amorphous material, principally Al and Fe combined with organic matter. It usually has a hue of 7.5YR or redder or its hue is 10YR near the upper boundary and becomes yellower with depth. When moist, the chroma is higher than 3 or the value is 3 or less. It contains 0.6% or more pyrophosphate-extractable Al+Fe in textures finer than sand and 0.4% or more in sands (coarse sand, sand, fine sand, and very fine sand). The ratio of pyrophosphate-extractable Al+Fe to clay (less than 0.002mm) is more than 0.05 and organic C exceeds 0.5%. Pyrophosphate-extractable Fe is at least 0.3%, or the ratio of organic C to pyrophosphate-extractable Fe is less than 20, or both are true. It is used with B alone (Bf), with B and h (Bhf), with B and g (Bfg), and with other suffixes. The criteria for "f" do not apply to Bgf horizons. The following horizons are differentiated on the basis of organic carbon content: Bf - 0.5% to 5% organic carbon. Bhf-more than 5% organic carbon.

g A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less. It is used with A and e (Aeg); with B alone (Bg); with B and f (Bfg); with B, h, and f (Bhfg); with B and t (Btg); with C alone (Cg); with C and k (Ckg); and several others. In some reddish parent materials, matrix colors of reddish hues and high chromas may persist despite long periods of reduction. In these soils, horizons are designated as g if there is gray mottling or if there is marked bleaching on ped faces or along cracks.

Aeg This horizon must meet the definitions of A,e, and g.

Bg These horizons are analogous to Bm horizons but they have colors indicative of poor drainage and periodic reduction. They include horizons occurring between A and C horizons in which the main features are (i) colors of low chroma, that is: chromas of 1 or less, without mottles on ped surfaces or in the matrix if peds are lacking; or chromas of 2 or less in hues of 10YR or redder, on ped surfaces or in the matrix if peds are lacking, accompanied by more promi-

nent mottles than those in the C horizon; or hues bluer than 10Y, with or without mottles on ped surfaces or in the matrix if peds are lacking. (ii) colors indicated in (i) and a change in structure from that of the C horizons. (iii) color indicated in (i) and illuviation of clay too slight to meet the requirements of Bt; or accumulation or iron oxide too slight to meet the limits of Bgf. (iv) colors indicated in (i) and removal of carbonates. Bg horizons occur in some Orthic Humic Gleysols and some Orthic Gleysols.

Bfg, Bhfg, Btg, and others. When used in any of these combinations the limits set for f, hf, t, and others must be met.

Bgf The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more. Pyrophosphate-extractable Al + Fe is less than the minimum limit specified for 'f' horizons. This horizon occurs in Fera Gleysols and Fera Humic Gleysols, and possibly below the Bfg of gleyed Podzols. It is distinguished from the Bfg of gleyed Podzols on the basis of the extractability of the Fe and Al. The Fe in the Bgf horizon is thought to have accumulated as a result of the oxidation of ferrous iron. The iron oxide formed is not associated intimately with organic matter or with Al, and it is sometimes crystalline. The Bgf horizons are usually prominently mottled, with more than half of the soil material occurring as mottles of high chroma.

Cg, Ckg, Ccag, Csg, Csag. When g is used with C alone, or with C and one of the lower-case suffixes k, ca, s, or sa, it must meet the difinition for C and for the particular suffix.

h A horizon enriched with organic matter. It is used with A alone (Ah); or with A and e (Ahe); or with B alone (Bh); or with B and f (Bhf).

Ah A horizon enriched with organic matter that either has a color value at least one unit lower than the underlying horizon or contains 0.5% more organic carbon than the IC, or both. It contains less than 17% organic carbon by weight.

Ahe An Ah horizon that has undergone eluviation as evidenced, under natural conditions, by streaks and splotches of differing shades of gray and often by platy structure. It may be overlain by a darker-colored Ah and underlain by a lighter-colored Ae.

Bh This horizon contains more than 1% organic carbon, less than 0.3% pyrophosphate-extractable Fe, and has a ratio of organic carbon to pyrophosphate-extractable Fe of 20 or more. Generally the color value and chroma are less than 3 when moist.

Bhf Defined under 'f'.

j Used as a modifier of the suffixes e, f, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be placed to the right and adjacent to the suffix it modifies. For example Bfgj means a Bf horizon with weak expression of gleying; Bfjgj means a B horizon with weak expression of both 'f' and 'g' features.

Aej It denotes an eluvial horizon that is thin, discontinuous or slightly discernible.

Btj It is a horizon with some illuviation of clay, but not enough to meet the limits of Bt.

Btgj, Bmgj. Horizons that are mottled but do not meet the criteria of Bg.

Bfj It is a horizon with some accumulation of pyrophosphate-extractable Al and Fe but not enough to meet the limits of Bf.

Bntj or Bnj. Horizons in which development of solonetzic B properties is evident but insufficient to meet the limits for Bn or Bnt.

k Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added. Most often it is used with B and m (Bmk) or C (Ck), and occasionally with Ah or Ap (Ahk, Apk), or organic horizons (Ofk, Omk).

m A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color or structure, or both. It has:

1. Evidence of alteration in one of the following forms:

   a) Higher chromas and redder hues than the underlying horizons.

   b) Removal of carbonates, either partially (Bmk) or completely (Bm).

2. Illuviation, if evident, too slight to meet the requirements of a Bt or a podzolic B.

3. Some weatherable minerals.

4. No cementation or induration and lacks a brittle consistence when moist. This suffix can be used as Bm, Bmgj, Bmk, and Bms.

n A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. It must also have the following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistence when dry. It is used with B, as Bn or Bnt.

p A horizon disturbed by man's activities, such as cultivation, logging, habitation, etc. It is used with A and O.

s A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by depressed crop growth, or by the presence of salt-tolerant plants. It is commonly used with C and k (Csk), but can be used with any horizon or combination of horizon and lowercase suffix.

sa A horizon with secondary enrich-

ment of salts more soluble than calcium and magnesium carbonates, in which the concentration of salts exceeds that present in the unenriched parent material. The horizon is 10 cm or more thick. The conductivity of the saturation extract must be at least 4 ms/cm and must exceed that of the C horizon by at least one-third.

t An illuvial horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), with B and n (Bnt), etc.

Bt A Bt horizon is one that contains illuvial layer-lattice clays. It forms below an eluvial horizon, but may occur at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than IC. It has the following properties:

1. If any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizons, as follows:

   a) If any part of the eluvial horizon has less than 15% total clay in the fine earth fraction (2mm) the Bt horizon must contain at least 3% more clay, e.g.,Ae 10% clay-Bt minimum 13% clay.

   b) If the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of the clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more, e.g., 20% clay increase in the Bt over Ae.

   c) If the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon, e.g. Ae 50% clay; Bt at least 58% clay.

2. A Bt horizon must be at least 5 cm thick. In some sandy soils where clay accumulation occurs in the lamellae, the total thickness of the lamellae should be more than 10 cm in the upper 150 cm of the profile.

3. In massive soils the Bt horizon should have oriented clays in some pores and also as bridges between the sand grains.

4. If peds are present, a Bt horizon shows clay skins on some of the vertical and horizontal ped surfaces and in the fine pores, or shows oriented clays in 1% or more of the cross section, as viewed in thin section.

5. If a soil shows a lithologic discontinuity between the eluvial

horizon and the Bt horizon, or if only a plow layer overlies the Bt horizon, the Bt horizon need show only clay skins in some part, either in some fine pores or on some vertical and horizontal ped surfaces. Thin sections should show that some part of the horizon has about 1% or more of oriented clay bodies.

Btj, Btj, and Btg are defined under j and g.

u A horizon that is markedly disrupted by physical or faunal processes other than cryoturbation. Evidence of marked disruption such as the inclusion of material from other horizons, absence of the horizon, etc. must be evident in at least half of the cross section of the pedon. Such turbation can result from blowdown of trees, mass movement of soil on slopes, and burrowing animals. It can be used with any horizon or subhorizon with the exception of A or B alone; e.g. Aeu, Bfu, BCu.

x A horizon of fragipan character. A fragipan is a loamy subsurface horizon of high bulk density and very low organic matter content. When dry, it has a hard consistence and seems to be cemented. When moist, it has moderate to weak brittleness. It frequently has bleached fracture planes and is overlain by a friable B horizon. Air dry clods of fragic horizons slake in water.

y A horizon affected by cryoturbation as manifested by disrupted and broken horizons,, incorporation of materials from other horizons and mechanical sorting in at least half of the cross section of the pedon. It is used with A, B, and C alone or in combination with other subscripts, e.g. Ahy, Ahgy, Bmy, Cy, Cgy, Cygj, etc.

z A frozen layer. It may be used with any horizon or layer, e.g. Ohz, Bmz, Cz, Wz.

Appendix E

DESCRIPTION OF LANDFORMS

E.1 GENETIC MATERIALS

Unconsolidated mineral component

The unconsolidated mineral component consists of clastic sediments that may or may not be stratified, but whose particles are not cemented together. They are essentially of glacial or post-glacial origin but include poorly consolidated and weathered bedrock.

Anthropogenic - Man-made or man-modified materials, including those associated with mineral exploitation and waste disposal.

Colluvial - Massive to moderately well stratified, nonsorted to poorly sorted sediments with any range of particle sizes from clay to boulders and blocks that have reached their present position by direct, gravity-induced movement.

They are restricted to products of mass-wasting whereby the debris is not carried by wind, water, or ice (excepting snow avalanches).

Eolian - Sediment, generally consisting of medium to fine sand and coarse silt particle sizes, that is well sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive. Individual grains may be rounded and show signs of frosting.

These materials have been transported and deposited by wind action.

Fluvial - Sediment generally consisting of gravel and sand with a minor fraction of silt and clay. The gravels are typically rounded and contain interstitial sand. Fluvial sediments are commonly moderately to well sorted and display stratification, but massive, nonsorted fluvial gravels do occur. These materials have been transported and deposited by streams and rivers. Finer textured Fluvial deposits of modern rivers are termed Alluvium.

Lacustrine - Sediment generally consisting of either stratified fine sand, silt, and clay deposited on the lake bed; or moderately well sorted and stratified sand and coarser materials that are beach and other nearshore sediments transported and deposited by wave action.

These are materials that either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action.

Marine - Unconsolidated deposits of clay, silt, sand, or gravel that are well to moderately well sorted and well stratified to moderately stratified (in some places containing shells). They have settled from suspension in salt or brackish water bodies or have

accumulated at their margins through shoreline processes such as wave action and longshore drift.

Morainal - Sediment generally consisting of well compacted material that is nonstratified and contains a heterogeneous mixture of particle sizes, often in a mixture of sand, silt, and clay that has been transported beneath, beside, on, within and in front of a glacier and not modified by any intermediate agent.

Saprolite - Rock containing a high proportion of residual silts and clays formed by alteration, chiefly by chemical weathering.

The rock remains in a coherent state, interstitial grain relationships are undisturbed and no downhill movement due to gravity has occurred.

Undifferentiated - A layered sequence of more than three types of genetic material outcropping on a steep erosional escarpment.

Volcanic - Unconsolidated pyroclastic sediments. These include volcanic dust, ash, cinders, and pumice.

Qualifying Descriptors

These have been introduced to qualify the genetic materials and to supply additional information about the mode of formation or depositional environment.

Glacial - Used to qualify nonglacial genetic materials or process modifiers where there is direct evidence that glacier ice exerted a strong but secondary or indirect control upon the mode of origin of the materials or mode of operation of the process. The use of this qualifying descriptor implies that glacier ice was close to the site of the deposition of a material or the site of operation of a process.

Glaciofluvial - Fluvial materials showing clear evidence of having been deposited either directly in front of or in contact with glacier ice.

Glaciolacustrine - Lacustrine materials deposited in contact with glacial ice.

Glaciomarine - Materials of glacial origin laid down in a marine environment, as a result of settling from melting, floating ice and ice shelves.

Organic component

The organic component consists of peat deposits containing >30% organic matter by weight that may be as thin as 10 cm if they overlie bedrock but are otherwise greater than 40 cm and generally greater than 60 cm thick. The classes and their definitions follow.

B	Bog
N	Fen
S	Swamp

Bog - A bog is a peat-covered or peat-filled area, generally with a high water table. Since the surface of the peatland is slightly elevated, bogs are either unaffected or partly affected by nutrient-rich groundwaters from the surrounding mineral soils. The groundwater is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat, underlain, at times, by fen peat.

Fen - A fen is a peat-covered or peat-filled area with a high water table, which is usually at the surface. The dominant materials are shallow to deep, well to moderately decomposed fen peat. The waters are mainly rich in nutrients (minerotrophic) and are derived from mineral soils. The peat materials are therefore higher in both nutrients and pH than the peats associated with bogs.

Swamp - A swamp is a peat-covered or peat-filled area. The peat surface is level or slightly concave in cross section. The water table is frequently at or above the peat surface. There is strong water movement from margins or other mineral sources. The microrelief is hummocky, with many pools present. The waters are neutral or slightly acid. The dominant peat materials are shallow to deep mesic to humic forest and fen peat.

E.2 GENETIC MATERIAL MODIFIERS

Material modifiers are used to qualify unconsolidated mineral and organic deposits. Particle-size classes serve to indicate the size, roundness, and sorting of unconsolidated mineral deposits. Fiber classes indicate the degree of decomposition and fiber size of organic materials.

Particle size classes for unconsolidated mineral materials

Blocky: An accumulation of angular particles greater than 256 mm in size.

Bouldery: An accumulation of rounded particles greater than 256 mm in size.

Clayey: An accumulation of particles where the fine earth fraction contains 35% or more clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Cobbly: An accumulation of rounded particles having a diameter of 64-256 mm.

Gravelly: An accumulation of rounded particles ranging in size from pebbles to boulders.

Loamy: An accumulation of particles of which fine earth fraction contains 35% or less clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Pebbly: An accumulation of rounded particles having a diameter of 2-64 mm.

Rubbly: An accumulation of angular fragments having a diameter of 2-256 mm.

Sandy: An accumulation of particles of which the fine earth fraction contains more than 70% by weight of fine sand or coarser particles. Particles greater than 2 mm occupy less than 35% by volume.

Silty: An accumulation of particles of which the fine earth fraction contains less than 15% of fine sand or coarser particles and has less than 35% clay. Particles greater than 2 mm occupy less than 35% by volume.

Fiber classes for organic materials

The amount of fiber and its durability are important characterizing features of organic deposits in that they reflect on the degree of decomposition of the material. The prevalence of woody materials in peats is also of prime importance.

Fibric: The least decomposed of all organic materials; there is a large amount of well-preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.

Mesic: Organic material in an intermediate stage of decompostion; intermediate amounts of fiber are present that can be identified as to their botanical origin.

Humic: Highly decomposed organic material; small amounts of fiber are present that can be identified as to their botanical origin. Fibers can be easily destroyed by rubbing.

Woody: Organic material containing more than 50% of woody fibers.

E.3 SURFACE EXPRESSION

The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials. When applied to consolidated materials, form refers to the product of their modification by geological processes. Surface expression also indicates the manner in which unconsolidated genetic materials relate to the underlying unit.

Consolidated and Unconsolidated mineral surface classes

Apron - A relatively gentle slope at the foot of a steeper slope and formed by materials from the steeper, upper slope.

Blanket - A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but still conforming to the general underlying topography.

Fan - A fan-shaped form similar to the segment of a cone and having a perceptible gradient from the apex to the toe.

Hummocky - A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls or depressions. Slopes are generally 9-70% (5-35 degrees).

Inclined - A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities. Slopes are 2-70% (1-35 degrees). The form of inclined slopes is not related to the initial mode of origin of the underlying material.

Level - A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 2% (1 degree).

Rolling - A very regular sequence of moderate slopes extending from rounded, sometimes confined concave depressions to broad, rounded convexities producing a wavelake pattern of moderate relief. Slope length is often 1.6 km or

greater and gradients are greater than 5% (3 degrees).

Ridged - A long, narrow elevation of the surface, usually sharp crested with steep sides. The ridges may be parallel, subparallel, or intersecting.

Steep - Erosional slopes, greater than 70% (35 degrees), on both consolidated and unconsolidated materials. The form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material.

Terraced - Scarp face and the horizontal or gently inclined surface (tread) above it.

Undulating - A very regular sequence of gentle slopes that extends from rounded, sometimes confined concavities to broad rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is 2-5% (1-3 degrees).

Veneer - Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer will range from 10 cm to 1 m in thickness and will possess no form typical of the material's genesis.

Organic surface classes

Blanket - A mantle of organic materials that is thick enough to mask minor irregularities in the underlying unit but still conforms to the general underlying topography.

Bowl - A bog or fen occupying concave-shaped depressions.

Domed - A bog with an elevated, convex, central area much higher than the margin. Domes may be abrupt (with or without a frozen core) or gently sloping or have a stepped surface.

Floating - A level organic surface associated with a pond or lake and not anchored to the lake bottom.

Horizontal - A flat peat surface not broken by marked elevations and depressions.

Plateau - A bog with an elevated, flat, central area only slightly higher than the margin.

Ribbed - A pattern of parallel or reticulate low ridges associated with fens.

Sloping - A peat surface with a generally constant slope not broken by marked irregularities.

Veneer - A thin (40 cm-1m) mantle of organic materials which generally conforms to the underlying topography. They may or may not be associated with discontinuous permafrost.

Appendix F

Detailed Soil Profile* Descriptions

Soil Symbol	Soil Name
RIV	Red River
SRE	Seine River
SOR	St. Norbert
DCS	Dencross

* Profile descriptions have been computer generated from detailed sample sites and analytical information stored in the Canada Soil Information System (CanSIS) data bank.

Analytical Methodology:

Field samples were collected from representative sites. Samples were air-dried and ground, and the less than 2 mm size fraction was used for subsequent analysis.

pH:	0.01 M $CaCl_2$
Organic Carbon:	Wet oxidation (Walkley-Black)
Total Nitrogen:	Macro-Kjeldahl; NO_2 and NO_3 not included
Equivalent:	Pressure method
Extractable Acidity:	$BaCl_2$ - Triethanolamine, pH 8.0
Cation Exchange Capacity:	Buffered NH_4Ac; pH 7.0 solution, done by atomic absorption procedure
Electrical Conductivity:	saturated paste, using conductivity cell-cup
Particle Size Analysis:	Pipette method. Pretreatment removal of organic matter and salts. Dispersion with sodium hexameta-phosphate
Water Content:	Pressure membrane method. Samples are ground, sieved, and oven-dried
Atterberg Limits:	A.S.T.M. Designation D423-54T, "Procedures for Testing Soils", pages 94-101
Shrinkage Limit:	Evaporation method

Codes for Engineering Classification

AASHO

A-1	= 10	A-3	= 30
A-1-a	= 11	A-4	= 40
A-1-b	= 12	A-5	= 50
A-2	= 20	A-6	= 60
A-2-4	= 24	A-7	= 70
A-2-5	= 25	A-7-5	= 75
A-2-6	= 26	A-7-6	= 76
A-2-7	= 27	A-8	= 80

Unified

GW	= 01	DL	= 11
GP	= 02	MH	= 12
GM	= 03	CH	= 13
GC	= 04	OH	= 14
SW	= 05	PT	= 15
SP	= 06	Cl	= 16
SM	= 07	GM-GC	= 17
SC	= 08	SM-SC	= 18
ML	= 09	CL-ML	= 19
CL	= 10		

APR 27, 1987

RIV MANITOBA 1985 PROFILE NO. 25

IDENTIFICATION: SURVEYED BY GP, FOR THE PURPOSE OF DETAILED SURVEY; PROVINCIAL SOIL SURVEY, WINNIPEG,MAN. STATUS: MODAL; EXTENSIVE.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: GLEYED REGO BLACK. MINERAL SOIL FAMILY: CLAYEY, MIXED CLAY, ALKALINE, EXTREMELY CALCAREOUS, COOL, SUBHUMID. SOIL MAP UNIT: TAXONOMIC SERIES, NOTATION: RIV, ASSOCIATED SOILS: SCY AND OBO. SOIL PHASES: NONSTONY AND NONROCKY.

LOCATION: MILITARY GRID REF. 14 UPL 2257 1450; NTS MAP AREA 62H 14; SW 29 9 2 E.

VEGETATION: CROPS-FIELD (MANAGED), CROPPED. WHEAT FIELD OAK ON HIGH (MYT) AREAS.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, CLAYEY (>35% CLAY), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), LACUSTRINE; LANDFORM CLASSIFICATION: LACUSTRINE, CLAYEY, LEVEL; SLOPE: CLASS 1 (0-0.5%), FACING LEVEL, SITE AT MIDDLE AND MIDDLE POSITION, LEVEL MICROTOPOGRAPHY,; SOIL MOISTURE AND DRAINAGE: SUBHUMID, IMPERFECTLY DRAINED, MODERATE AND SLOW SURFACE RUNOFF; NONSTONY; NONROCKY; PRESENT LAND USE: CROPLAND.

SPECIAL NOTES: SLICKENSIDES IN CKGJ2 HORIZON.

AP: 0 TO 25 CM, RANGE 15 TO 25 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 3/0, MATRIX DRY 2.5Y 3.5/0; CLAY; VERY WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; STICKY, FIRM, PLASTIC CONSISTENCE; SLIGHTLY POROUS; VERY WEAK EFFERVESCENCE; SMOOTH, CLEAR HORIZON BOUNDARY.

CKGJ1: 25 TO 60 CM, RANGE 25 TO 35 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 4/2; CLAY; FEW, FINE, FAINT MOTTLES; MODERATE TO STRONG, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; MODERATE TO STRONG, FINE, SUBANGULAR BLOCKY AND GRANULAR SECONDARY STRUCTURE PSEUDO; STICKY, FRIABLE, PLASTIC CONSISTENCE; MODERATELY POROUS; MODERATE AND STRONG EFFERVESCENCE; MODERATELY CALCAREOUS; HOMOGENEOUS ; WAVY, GRADUAL HORIZON BOUNDARY.

CKGJ2: 60 TO 100 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 4.5/2; CLAY; FEW, FINE, FAINT AND DISTINCT, 2.5Y 6/7 MOTTLES; MODERATE TO STRONG, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; MODERATE TO STRONG, FINE TO MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE PSEUDO; STICKY, FRIABLE, PLASTIC CONSISTENCE; MODERATELY POROUS; MODERATE AND STRONG EFFERVESCENCE; MODERATELY CALCAREOUS; HOMOGENEOUS .

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	TOTAL N (%)	CALC CARB EQU.%	CAL-CITE (%)	DOLO-MITE (%)	EXTR ACID	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
AP	6.8	4.23	0.30	0.0			8.6	50.1		29.3	13.0	0.2	1.4
CKGJ1	7.7			11.5	9.9	1.4		43.1		30.5	14.6	0.3	0.8
CKGJ2	7.8			10.5	8.8	1.5		43.9		26.1	17.7	0.4	0.8

RIV MANITOBA 1985 PROFILE NO. 25

CHEMICAL DATA (SURVEY)

HORIZON	ELEC COND (MMHOS/CM)	% H2O AT SATUR
AP	0.4	81.0
CKGJ1	0.3	74.5
CKGJ2	0.5	79.0

PHYSICAL DATA (SURVEY)

		PARTICLE SIZE ANALYSIS													
		% PASSING										% OF SAMPLE			
HORIZON		3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
AP					99						4		21	75		0.91
CKGJ1					99						4		27	69		1.20
CKGJ2					99						1		20	79		1.17

PHYSICAL DATA

		SURVEY (CON'T)						ENGINEERING					
		MOISTURE STATUS (%)											
HORIZON		0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
AP				22.2		41.6								
CKGJ1				19.5		41.2								
CKGJ2				23.0		39.7	29.0	77.0	16.0					

APR 27, 1987

SRE MANITOBA 1985 PROFILE NO. 20

IDENTIFICATION: SURVEYED BY GP, FOR THE PURPOSE OF DETAILED SURVEY; PROVINCIAL SOIL SURVEY, WINNIPEG,MAN. STATUS: MODAL; EXTENSIVE.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: GLEYED CUMULIC REGOSOL. MINERAL SOIL FAMILY: CLAYEY, MIXED CLAY, ALKALINE, STRONGLY CALCAREOUS, COOL, SUBHUMID. SOIL MAP UNIT: TAXONOMIC SERIES, NOTATION: SRE. SOIL PHASES: VERY GENTLY SLOPING AND NONSTONY AND NONROCKY.

LOCATION: MILITARY GRID REF. 14 UPL 2105 245; NTS MAP AREA 62H 11; NE 13 8 1 E.

VEGETATION: FOREST,HARDWOOD, MATURE. ELM HSH OAK SHRUBS GRASSES.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, CLAYEY (>35% CLAY), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), FLUVIAL, MIXED; LANDFORM CLASSIFICATION: FLUVIAL, CLAYEY, UNDULATING; SLOPE: CLASS 3 (2-5%), FACING LEVEL, SITE AT UPPER SLOPE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,; SOIL MOISTURE AND DRAINAGE: SUBHUMID, IMPERFECTLY DRAINED, SLOWLY PERVIOUS, MODERATE SURFACE RUNOFF; NONSTONY; NONROCKY; PRESENT LAND USE: UNPRODUCTIVE WOODLAND.

SPECIAL NOTES: SAMPLED ALONG THE LA SALLE RIVER ON THE ALLUVIUM WHICH IS SUBJECT TO FLOODING

LFH: 3 TO 0 CM, RANGE 2 TO 3 CM; HORIZON MOIST; MATRIX MOIST ; SMOOTH, CLEAR HORIZON BOUNDARY.

CGJ: 0 TO 26 CM, RANGE 20 TO 27 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 3/1; CLAY; MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE PSEUDO; MODERATE TO STRONG, FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE PSEUDO; FRIABLE, VERY PLASTIC CONSISTENCE; PLENTIFUL, FINE ROOTS; MODERATELY POROUS; VERY WEAK EFFERVESCENCE; MODERATELY CALCAREOUS; WAVY, CLEAR HORIZON BOUNDARY.

CKGJ: 26 TO 50 CM, RANGE 18 TO 25 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 4/2; SILTY CLAY AND CLAY; FEW, FINE, FAINT MOTTLES; MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE PSEUDO; MODERATE TO STRONG, FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE PSEUDO; FRIABLE, VERY PLASTIC CONSISTENCE; PLENTIFUL, FINE ROOTS; MODERATELY POROUS; WEAK EFFERVESCENCE; MODERATELY CALCAREOUS; WAVY, CLEAR HORIZON BOUNDARY.

AHB: 50 TO 65 CM, RANGE 10 TO 15 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 3/0; CLAY; MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE PSEUDO; MODERATE TO STRONG, FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE PSEUDO; FRIABLE, VERY PLASTIC CONSISTENCE; PLENTIFUL, FINE ROOTS; MODERATELY POROUS; VERY WEAK EFFERVESCENCE; WAVY, CLEAR HORIZON BOUNDARY.

CKGJ1: 65 TO 80 CM, RANGE 10 TO 15 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 4.5/2; CLAY; FEW, FINE, FAINT MOTTLES; WEAK TO MODERATE, MEDIUM, SUBANGULAR BLOCKY STRUCTURE PSEUDO; FIRM, VERY PLASTIC CONSISTENCE; FEW, MEDIUM ROOTS; MODERATELY POROUS; MODERATE EFFERVESCENCE; MODERATELY CALCAREOUS; WAVY, CLEAR HORIZON BOUNDARY.

CKGJ2: 80 TO 100 CM; HORIZON MOIST; 2.5Y 5/2; SILTY CLAY AND CLAY; COMMON, MEDIUM, PROMINENT, 7.5YR 5/6 MOTTLES; WEAK TO MODERATE, MEDIUM, SUBANGULAR BLOCKY STRUCTURE PSEUDO; FIRM, PLASTIC AND VERY PLASTIC CONSISTENCE; FEW, MEDIUM ROOTS; MODERATELY POROUS; COMMON, FINE AND MEDIUM, IRREGULAR LIME AND IRON-MANGANESE CONCRETIONS LOCATED LOCAL CONCENTRATIONS ; STRONG EFFERVESCENCE; STRONGLY CALCAREOUS.

SRE MANITOBA 1985 PROFILE NO. 20

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	TOTAL N (%)	CALC CARB EQU.%	CAL-CITE (%)	DOLO-MITE (%)	EXTR ACID	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LFH	7.2	9.81	0.61				6.4	53.8		33.2	12.6	0.2	2.0
CGJ	7.3	3.04	0.31	5.4	0.0	5.0	2.4	41.1		25.9	10.7	0.2	1.2
CKGJ	7.5			6.9	0.0	6.3	2.6	41.4		26.9	11.0	0.2	1.1
AHB	7.5	1.86	0.17				5.2	52.4		28.2	15.6	0.2	0.9
CKGJ1	7.8			14.4	14.4	0.0		41.3		24.4	16.7	0.5	0.7
CKGJ2	7.9			15.9	10.4	5.1		34.2		23.6	15.8	1.1	0.6

CHEMICAL DATA (SURVEY)

HORIZON	ELEC COND (MMHOS/CM)	% H2O AT SATUR
LFH	1.1	127.4
CGJ	0.6	75.5
CKGJ	0.4	66.8
AHB	0.4	74.5
CKGJ1	0.8	78.0
CKGJ2	1.9	82.2

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LFH				99										
CGJ				99						3		36	61	
CKGJ				99						2		44	54	
AHB				99						4		23	73	
CKGJ1				99						1		22	77	
CKGJ2				99						1		43	56	

APR 27, 1987

SRE MANITOBA 1985 PROFILE NO. 20

PHYSICAL DATA

	SURVEY (CON'T)					ENGINEERING							
	MOISTURE STATUS (%)												
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LFH													
CGJ			19.6										
CKGJ													
AHB													
CKGJ1						28.0	76.0	16.0		1.9	30.0	76	13
CKGJ2			20.3			27.0	73.0	18.0		1.8	29.0	76	13

APR 27, 1987

SOR MANITOBA 1985 PROFILE NO. 21

IDENTIFICATION: SURVEYED BY GP, FOR THE PURPOSE OF DETAILED SURVEY; PROVINCIAL SOIL SURVEY, WINNIPEG,MAN. STATUS: MODAL.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC DARK GRAY. MINERAL SOIL FAMILY: CLAYEY, MIXED CLAY, ALKALINE, WEAKLY CALCAREOUS, COOL. SUBHUMID. SOIL MAP UNIT: TAXONOMIC SERIES, NOTATION: SOR. SOIL PHASES: LEVEL AND NONSTONY AND NONROCKY.

LOCATION: MILITARY GRID REF. 14 UPL 1995 365; NTS MAP AREA 62H 11; NW 24 8 1 E.

VEGETATION: FOREST,MIXED. KEY SPECIES LISTING: 1 OB. OAK,HAZEL,MULBERRY,CHOKECHERRY, GRASSES.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, CLAYEY (>35% CLAY), WEAKLY CALCAREOUS (1 TO 6% CACO3), LACUSTRINE, MIXED; LANDFORM CLASSIFICATION: LACUSTRINE, CLAYEY, LEVEL; SLOPE: CLASS 2 (0.5-2%), FACING LEVEL, SITE AT UPPER SLOPE POSITION, LEVEL MICROTOPOGRAPHY,; SOIL MOISTURE AND DRAINAGE: SUBHUMID, WELL DRAINED, SLOWLY PERVIOUS, MODERATE SURFACE RUNOFF; NONSTONY; NONROCKY; PRESENT LAND USE: UNPRODUCTIVE WOODLAND.

SPECIAL NOTES: REPRESENTATIVE PRISMATIC STRUCTURE IN BTJ (BT). THE AHE DRYS VERY LIGHT

LFH: 3 TO 0 CM; MATRIX MOIST ; MATERIAL COMPOSITION 50 AND 50% LEAVES AND HERBACEOUS FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

AHE: 0 TO 16 CM, RANGE 10 TO 20 CM; HORIZON MOIST; MATRIX MOIST 10YR 2.5/1, MATRIX DRY 10YR 4.5/1; CLAY; MODERATE TO STRONG, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE PSEUDO; FRIABLE, VERY PLASTIC CONSISTENCE; PLENTIFUL, FINE ROOTS; MODERATELY POROUS; WAVY, CLEAR HORIZON BOUNDARY.

BT1: 16 TO 50 CM, RANGE 20 TO 32 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/1.5; CLAY AND HEAVY CLAY; MODERATE TO STRONG, MEDIUM, PRISMATIC STRUCTURE PSEUDO; MODERATE TO STRONG, MEDIUM TO COARSE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; FIRM, VERY PLASTIC CONSISTENCE; PLENTIFUL, FINE ROOTS; MODERATELY POROUS; COMMON CLAY FILMS ; WAVY, GRADUAL HORIZON BOUNDARY.

BT2: 50 TO 80 CM, RANGE 25 TO 30 CM; HORIZON MOIST; MATRIX MOIST 10YR 3.5/1; CLAY AND HEAVY CLAY; WEAK, COARSE, SUBANGULAR BLOCKY STRUCTURE PSEUDO; WEAK, MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE; FIRM, VERY PLASTIC CONSISTENCE; FEW, FINE ROOTS; MODERATELY POROUS; COMMON CLAY FILMS ; WAVY, CLEAR HORIZON BOUNDARY.

CKGJ: 80 TO 100 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 3.5/2; SILTY CLAY AND CLAY; FEW, FINE, FAINT MOTTLES; STRUCTURELESS STRUCTURE PSEUDO; MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE; FIRM, VERY PLASTIC CONSISTENCE; FEW, FINE ROOTS; SLIGHTLY POROUS; STRONG EFFERVESCENCE; MODERATELY CALCAREOUS AND STRONGLY CALCAREOUS; HOMOGENEOUS .

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	TOTAL N (%)	CALC CARB EQU.%	CAL-CITE (%)	DOLO-MITE (%)	EXTR ACID	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LFH	6.4	16.23	1.03				9.6	66.5		33.1	15.2	0.2	2.1
AHE	5.9	5.67	0.46				11.2	50.3		22.8	13.6	0.3	1.1
BT1	5.6	2.87	0.21				15.6	54.8		19.5	16.0	0.7	1.0
BT2	5.0	2.65	0.20				15.8	54.9		19.1	18.7	1.7	0.9
CKGJ	7.7			11.0	7.0	3.0		44.1		22.8	17.2	1.7	0.5

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CHEMICAL DATA (SURVEY)

HORIZON	ELEC COND (MMHOS/CM)	% H2O AT SATUR
LFH	1.1	210.7
AHE	0.6	80.7
BT1	0.2	73.7
BT2	0.6	80.0
CKGJ	2.1	83.1

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS													
	% PASSING				% OF SAMPLE									
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LFH				99										
AHE				99						6		29	65	
BT1				99						2		14	84	
BT2				99						2		17	81	
CKGJ				99						1		59	40	

PHYSICAL DATA

	SURVEY (CON'T)					ENGINEERING						
	MOISTURE STATUS (%)											
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LFH													
AHE													
BT1													
BT2						33.0	77.0					75	13
CKGJ			22.8			30.0	77.0	16.0		1.9	29.0	76	13

DCS MANITOBA 1985 PROFILE NO. 22

IDENTIFICATION: SURVEYED BY PMH, FOR THE PURPOSE OF DETAILED SURVEY; PROVINCIAL SOIL SURVEY, WINNIPEG,MAN. STATUS: MODAL; EXTENSIVE.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: GLEYED REGO BLACK. MINERAL SOIL FAMILY: CLAYEY/LOAMY, MONTHORILLONITIC AND ILLITIC, ALKALINE, STRONGLY CALCAREOUS, COOL, SUBHUMID. SOIL MAP UNIT: TAXONOMIC SERIES, NOTATION: DCS, ASSOCIATED SOILS: RIVAND FTY. SOIL PHASES: LEVEL.

LOCATION: MILITARY GRID REF. 14 UPL 2830 1426; NTS MAP AREA 62H 14; SE 26 09 2 E.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, FINE LOAMY AND FINE SILTY (18 TO 35% CLAY) AND CLAYEY (>35% CLAY), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), LACUSTRINE; LANDFORM CLASSIFICATION: LACUSTRINE, CLAYEY, LEVEL; SLOPE: 0% SIMPLE SLOPE OF CLASS 1 (0-0.5%), FACING LEVEL; SOIL MOISTURE AND DRAINAGE: SUBHUMID, IMPERFECTLY DRAINED, MODERATELY PERVIOUS, SLOW SURFACE RUNOFF, SEEPAGE ABSENT; NONSTONY; NONROCKY; PRESENT LAND USE: CROPLAND.

SPECIAL NOTES: SITE SAMPLED FOR BULK DENSITY AND FIELD CAPACITY. TILLED WHEAT STUBBLE. CLAY AT DEPTH OF 120CM.

APK: 0 TO 18 CM, RANGE 17 TO 22 CM; HORIZON MOIST; MATRIX MOIST 10YR 2.5/1, MATRIX DRY 10YR 3/1; SILTY CLAY; WEAK TO MODERATE, VERY COARSE, SUBANGULAR BLOCKY STRUCTURE; WEAK, MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE; FIRM, HARD, VERY PLASTIC CONSISTENCE; ABUNDANT, VERY FINE, RANDOM, INPED ROOTS; HIGHLY POROUS, MANY, MICRO, RANDOM PORES; MODERATE EFFERVESCENCE; MODERATELY CALCAREOUS; SMOOTH, CLEAR HORIZON BOUNDARY; MILDLY ALKALINE 7.4-7.8 FIELD PH.

AC: 18 TO 50 CM, RANGE 28 TO 35 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 3.5/2, MATRIX DRY 10YR 4/1; SILTY CLAY; FEW, MEDIUM, FAINT, 2.5Y 5/2 MOTTLES; WEAK TO MODERATE, VERY COARSE, ANGULAR BLOCKY STRUCTURE; WEAK TO MODERATE, MEDIUM, GRANULAR SECONDARY STRUCTURE; FIRM, HARD, VERY PLASTIC CONSISTENCE; PLENTIFUL, VERY FINE, RANDOM, INPED ROOTS; HIGHLY POROUS, MANY, MICRO, RANDOM PORES; MODERATE EFFERVESCENCE; STRONGLY CALCAREOUS; WAVY, CLEAR HORIZON BOUNDARY; MILDLY ALKALINE 7.4-7.8 FIELD PH.

2CKGJ: 50 TO 85 CM, RANGE 32 TO 38 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 5/4, MATRIX DRY 10YR 6.5/2; SILTY CLAY LOAM; COMMON, FINE, DISTINCT MOTTLES; 2.5Y 6/6 MOTTLES; VERY WEAK, MEDIUM, GRANULAR STRUCTURE; FRIABLE, SLIGHTLY HARD, SLIGHTLY PLASTIC CONSISTENCE; PLENTIFUL, VERY FINE, RANDOM, INPED ROOTS; MODERATELY POROUS, MANY, FINE, RANDOM, CONTINUOUS, SIMPLE, TUBULAR PORES; MODERATE EFFERVESCENCE; VERY STRONGLY CALCAREOUS; SMOOTH, GRADUAL HORIZON BOUNDARY; MILDLY ALKALINE 7.4-7.8 FIELD PH.

2CKG: 85 TO 110 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/4, MATRIX DRY 10YR 7/3; SILT LOAM; MANY, FINE, DISTINCT MOTTLES; 2.5Y 6/6 MOTTLES; MODERATE, MEDIUM, PLATY STRUCTURE PSEUDO AND LAMINATED; WEAK, FINE TO MEDIUM, PLATY SECONDARY STRUCTURE LAMINATED; VERY FRIABLE, SOFT, NONPLASTIC CONSISTENCE; FEW, VERY FINE, RANDOM, INPED ROOTS; MODERATELY POROUS, MANY, MEDIUM, VERTICAL, INPED, CONTINUOUS, SIMPLE, TUBULAR PORES; WEAK EFFERVESCENCE; EXTREMELY CALCAREOUS; MILDLY ALKALINE 7.4-7.8 FIELD PH.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	TOTAL N (%)	CALC CARB EQU.%	CAL-CITE (%)	DOLO-MITE (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
APK	7.5	3.09	0.28	21.0	12.6	7.8	31.6		21.3	12.9	0.2	1.1
AC	7.8	1.09	0.11	26.3	15.9	9.7	27.6		13.1	17.8	0.3	0.6
2CKGJ	7.8			39.2	8.1	28.6	14.1		9.7	12.2	0.3	0.4
2CKG	7.8			42.9	4.8	35.1	8.6		5.4	8.9	0.5	0.3

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DCS MANITOBA 1985 PROFILE NO. 22

CHEMICAL DATA (SURVEY)

HORIZON	ELEC COND (MMHOS/CM)	% H2O AT SATUR
APK	0.7	56.0
AC	0.4	57.0
2CKGJ	0.5	40.0
2CKG	2.0	37.5

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS														
	% PASSING				% OF SAMPLE										
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
APK				99			1	3	11	15		42	43		1.01
AC				99				1	8	9		45	46		1.33
2CKGJ				99			1	1	13	15		52	33		1.34
2CKG				99				2	16	18		64	18		1.52

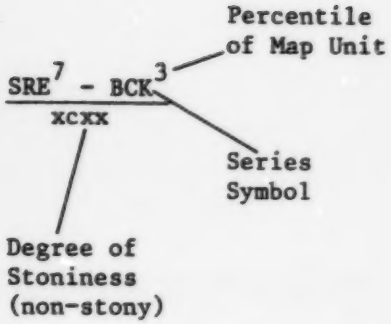
PHYSICAL DATA

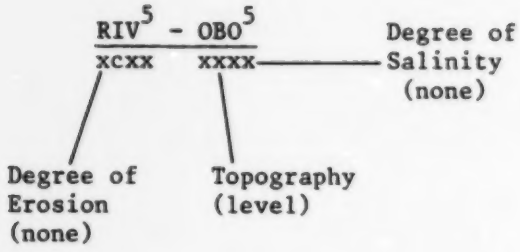
	SURVEY (CON'T)					ENGINEERING						
	MOISTURE STATUS (%)											
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
APK			15.8		33.7								
AC			15.4		30.3	21.0	55.0	31.0		1.8	23.0	76	13
2CKGJ			11.7		26.1								
2CKG			7.1		22.2	17.0	25.0	30.0		1.8	13.0	40	10

APPENDIX G

MAP UNIT SYMBOLOGY

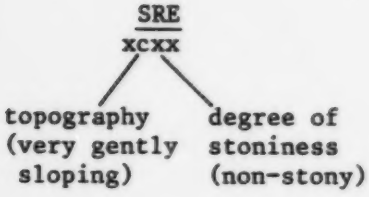
Compound Map Units

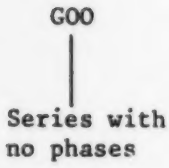




In a compound unit where two series share the same denominator, the phases apply to both series accordingly.

Simple Map Units





Phases

Degree of Erosion

x noneroded or minimal
1 slightly eroded
2 moderately eroded
3 severely eroded
o overblown

Slope Class

x	0-2%	level to nearly level
c	2-5%	very gently sloping
d	5-9%	gently sloping
e	9-15%	moderately sloping
f	15-30%	strongly sloping
g	30-45%	very strongly sloping
h	45-70%	extremely sloping

Stoniness

x nonstony
1 slightly stony
2 moderately stony
3 very stony
4 exceedingly stony
5 excessively stony

Degree of Salinity

	Cond. (mS/cm)
x nonsaline	0-4
s weakly saline	4-8
t moderately saline	8-15
u strongly saline	15+

Soil Legend

Soil Symbol	Soil Name	Surface Texture	Soil Drainage	Mode of Deposition	Family Particle Size	Subgroup
BCK	Black Lake	C	WELL	Fluvial	Clayey	CU.R
DCS	Dencross	C	IMPER	Lacustrine	Clayey/Loamy	GLR.BL
DFS	Dufresne	C	POOR	Fluvial	Clayey	R.HG
DHO	Deadhorse	C	IMPER	Lacustrine	Clayey	GLR.BL
FTE	Fortier	SIC	IMPER	Fluvial	Clayey	GLCU.R
GOO	Glenmoor	C	POOR	Lacustrine	Clayey/Loamy	R.HG(Carb)
GVS	Gervais	SICL	IMPER	Fluvial	Loamy	GLCU.R
HDG	Hodgson	SICL	WELL	Fluvial	Loamy	CU.R
MYT	Myrtle	C	WELL	Lacustrine	Clayey	O.BL
OBO	Osborne	C	POOR	Lacustrine	Clayey	R.HG
PGK	Pigeon Lake	SICL	IMPER	Fluvial	Loamy/Clayey	GLCU.R
PME	Plum Coulee	C	IMPER	Lacustrine	Clayey	GL.BL
RIV	Red River	C	IMPER	Lacustrine	Clayey	GLR.BL
SCY	Scanterbury	C	IMPER	Lacustrine	Clayey	GL.BL
SOR	St Norbert	C	WELL	Lacustrine	Clayey	O.DG
SRE	Seine River	C	IMPER	Fluvial	Clayey	GLCU.R
WWB	Willowbend	L	POOR	Fluvial	Loamy	R.HG